PUBLIC WORKS APPROPRIATIONS FOR 1961

HEARINGS

BEFORE THE

SUBCOMMITTEES OF THE
COMMITTEE ON APPROPRIATIONS
HOUSE OF REPRESENTATIVES

EIGHTY-SIXTH CONGRESS

SECOND SESSION

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PART 3

Atomic Energy Commission
Nuclear Propelled Aircraft Program

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DEPOSITED BY THE
UNITED STATES OF AMERICA

PUBLIC WORKS APPROPRIATIONS FOR 1961

TUESDAY, APRIL 19, 1960.

ATOMIC ENERGY COMMISSION

WITNESSES

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Mr. CANNON. The committee will be in order.

We shall take up this morning appropriations for the Atomic Energy Commission.

We have with us Chairman McCone, Commissioner Graham, Commissioner Floberg, Commisioner Williams, and Commissioner Wilson.

Operating Expenses

Program and financing

	1959 actual	1960 estimate	1961 estimate
Program by activities:			
1. Raw materials	$705,512,144	$733,646,000	$630,000,000
2. Special nuclear materials	541,303,455	563,000,000	567,700,000
3. Weapons	484,879,166	492,100,000	495,000,000
4. Reactor development	347,057,273	402,400,000	436,200,000
5. Physical research	114,645,885	147,644,000	158,900,000
6. Biology and medicine	42,007,757	49,000,000	54,200,000
7. Training, education, and information	13,033,893	13,500,000	14,200,000
8. Civilian applications of isotopes development and nuclear explosives	5,762,397	12,000,000	12,500,000
9. Community	16,509,601	14,632,000	10,204,000
10. Program direction and administration	49,412,165	52,000,000	54,900,000
11. Security investigations	6,995,176	6,097,000	5,862,000
12. Other costs	5,559,672	5,800,000	6,500,000
13. Adjustment to prior year costs	−3,483,142		
Total program costs [1]	2,329,195,442	2,491,819,000	2,446,166,000
14. Relation of costs to accrued expenditures:			
Costs financed from accrued expenditures of other years, net (−)	−14,641,975	−8,866,760	
Expenditures accrued for costs of other years, net			20,029,000
Total accrued expenditures	2,314,553,467	2,482,952,240	2,466,195,000
Unpaid undelivered orders brought forward	−608,003,590	−641,038,142	−701,063,322
Adjustment of unpaid undelivered orders brought forward	−127,216		
Unpaid undelivered orders carried forward	641,038,142	701,063,322	707,768,322
Total program (obligations)	2,347,460,803	2,542,977,420	2,472,900,000
Financing:			
Comparative transfers to other accounts	516,185	356,000	
1959 appropriation available in 1958	1,129,167		
Advances and reimbursements from non-Federal sources (revenues applied)	−28,079,323	−26,850,000	−22,600,000
Unobligated balance no longer available	152,369,420	23,000,000	
New obligational authority	2,473,396,252	2,539,483,420	2,450,300,000
New obligational authority:			
Appropriation	2,397,406,000	2,389,114,000	2,427,300,000
Transferred to "Salaries and expenses," National Science Foundation (72 Stat. 881; 73 Stat. 364)	−2,000,000	−2,000,000	
Appropriation (adjusted)	2,395,406,000	2,387,114,000	2,427,300,000
Reappropriation	77,990,252	152,369,420	23,000,000

[1] Includes capital outlay for equipment: 1959, $87,478,311; 1960, $93,358,000; 1961, $99,180,000. See table below.

Object classification

	1959 actual	1960 estimate	1961 estimate
ATOMIC ENERGY COMMISSION			
Total number permanent positions	7,413	7,373	7,479
Full-time equivalent of all other positions	86	51	54
Average number of all employees	6,872	6,894	7,002
Number of employees at end of year	6,855	7,012	7,094
Average grade and salary, grades established by the Atomic Energy Commission	8.7 $7,126	8.9 $7,272	8.9 $7,346
01 Personal services:			
Permanent positions	$48,252,876	$49,656,845	$51,029,608
Positions other than permanent	492,300	366,000	400,000
Other personal services	1,971,793	2,261,155	2,170,392
Total personal services	50,716,969	52,284,000	53,600,000
02 Travel	2,837,707	3,339,000	3,650,000
03 Transportation of things	6,610,180	11,186,000	13,114,000
04 Communication services	4,673,953	4,472,000	4,680,000
05 Rents and utility services	209,981,716	212,889,000	214,557,000
06 Printing and reproduction	481,868	560,000	619,000
07 Other contractual services	1,232,117,590	1,326,548,647	1,305,624,000
Services performed by other agencies	24,832,863	29,196,000	31,276,000
08 Supplies and materials	694,324,709	769,156,000	703,318,000
09 Equipment	86,518,167	95,995,000	101,606,000
11 Grant, subsidies, and contributions	7,693,507	7,971,000	10,655,000
12 Pensions, annuities, and insurance claims	1,059		
13 Refunds, awards, and indemnities	23,598	68,000	71,000
15 Taxes and assessments	18,043	7,000	7,000
Unvouchered	432	100,000	100,000
1959 program obligated in 1958	−1,129,167		
Total, Atomic Energy Commission	2,319,703,194	2,513,771,647	2,442,877,000
ALLOCATION ACCOUNTS			
Total number of permanent positions	39	56	53
Full-time equivalent of all other positions	1	2	2
Average number of all employees	39	57	55
Number of employees at end of year	39	56	56
Average GS grade and salary	6.7 $5,565	6.9 $5,814	7.0 $5,909
01 Personal services:			
Permanent positions	$218,277	$315,795	$311,300
Positions other than permanent	2,312	7,000	7,000
Other personal services	22,174	23,605	15,500
Total personal services	242,763	346,400	333,800
02 Travel	427	1,021	1,000
03 Transportation of things	2,054	4,750	5,000
04 Communication services	320	700	700
05 Rents and utility services	583	1,300	1,400
07 Other contractual services	27,244,091	28,653,221	29,503,216
08 Supplies and materials	262,254	177,270	156,400
09 Equipment	698	1,200	1,000
11 Grants, subsidies, and contributions	4,247	19,711	20,284
13 Refunds, awards, and indemnities	165	100	100
15 Taxes and assessments	7	100	100
Total, allocation accounts	27,757,609	29,205,773	30,023,000
Total obligations	2,347,460,803	2,542,977,420	2,472,900,000
Obligations are distributed as follows:			
Atomic Energy Commission	2,319,703,194	2,513,771,647	2,442,877,000
Department of State	−8,488		
Department of the Interior:			
Geological Survey	−2,316		
Bureau of Mines	163,712	369,553	350,000
Navy	−255	20,260	
Department of Health, Education, and Welfare (Public Health Service)	−117		
Army	27,605,073	28,815,960	29,673,000

Plant Acquisition and Construction

Program and financing

	1959 actual	1960 estimate	1961 estimate
Program by activities:			
Facilities for—			
1. Raw materials	$78,717	$100,000	$100,000
2. Special nuclear materials	76,410,307	159,755,000	56,966,000
3. Weapons	36,800,220	42,449,000	27,500,000
4. Reactor development	130,705,216	190,332,500	101,644,000
5. Physical research	41,099,069	67,796,000	23,000,000
6. Biology and medicine	2,198,127	3,772,000	4,300,000
7. Training, education, and information	896,209	1,043,000	150,000
8. Civilian applications of isotopes development and nuclear explosives		3,400,000	
9. Communities	2,282,149	3,227,000	1,240,000
10. Administration	656,968	691,000	600,000
Total obligations	291,126,982	472,565,500	215,500,000
Financing:			
Unobligated balance brought forward	−222,864,482	−209,915,500	
Recovery of prior year obligations	−28,249,000	−150,000	
Unobligated balance carried forward	209,915,500		
Appropriation (new obligational authority)	249,929,000	262,500,000	215,500,000

Object classification

		1959 actual	1960 estimate	1961 estimate
	ATOMIC ENERGY COMMISSION			
03	Transportation of things	$19,818	$69,000	$38,000
04	Communication services	560	1,000	1,000
07	Other contractual services	7,654,541	20,554,000	21,638,000
	Services performed by other agencies	8,707		
08	Supplies and materials	3,642,536	10,000,000	3,000,000
10	Lands and structures	273,438,663	437,189,914	190,023,000
13	Refunds, awards, and indemnities	61,853	100,000	100,000
	Total, Atomic Energy Commission	284,826,678	467,913,914	214,800,000
	ALLOCATION ACCOUNTS			
	Total number of permanent positions	5	17	
	Average number of all employees	3	16	
	Number of employees at end of year	0	0	
	Average GS grade and salary	6.2 $5,215	6.1 $5,230	
01	Personal services:			
	Permanent positions	$18,810	$79,688	
	Positions other than permanent	233	5,000	
	Other personal services	233	812	
	Total personal services	19,276	85,500	
02	Travel	1,188	5,041	
03	Transportation of things	6,640	517	
04	Communication services	28	129	
05	Rents and utility services	1,261	3,000	
06	Newspapers and periodicals	43		
07	Other contractual services	408,954	580,575	700,000
	Services performed by other agencies	5,633	5,000	
08	Supplies and materials	4,358,363	905	
10	Land and structures	1,498,903	3,970,919	
11	Grants, subsidies, and contributions	15		
	Total, allocation accounts	6,300,304	4,651,586	700,000
	Total obligations	291,126,982	472,565,500	215,500,000
	Obligations are distributed as follows:			
	Atomic Energy Commission	284,826,678	467,913,914	214,800,000
	Department of Agriculture (Soil Conservation Service)	13,209		
	Department of Commerce:			
	Bureau of Public Roads	110,399	13,804	
	Maritime activities	1,202,820	3,044,758	
	Department of the Interior (Bureau of Indian Affairs)	1,587		
	General Services Administration	4,362,620		
	Army	609,669	1,593,024	700,000

JUSTIFICATION OF THE ESTIMATES

We shall insert first pages 1 to 13 of the justifications. (The justifications follow:)

GENERAL STATEMENT FOR OPERATING EXPENSES

ESTIMATE OF APPROPRIATION

This book contains the budget estimates for the appropriation "Operating expenses" for fiscal year 1961. The estimates provide for total obligations of $2,486,900,000 to be funded by: (1) a new appropriation of $2,427,300,000; (2) the reappropriation of $37 million in unobligated balances estimated to be available at the end of the fiscal year 1960; and (3) an estimated $22,600,000 to be received as revenues from non-Federal sources during the fiscal year.

ESTIMATES OF COSTS AND OBLIGATIONS

The budget estimates for this appropriation are stated in terms of accrued costs for each of the AEC's 12 operating programs. "Accrued costs" denotes the actual application of labor, materials, equipment, and services to the program during the year, but excludes depreciation of facilities used in the operations. The AEC does, however, maintain accounts for depreciation for the purpose of determining total costs of production and for use in establishing prices for services rendered or products sold to others.

The net costs of operation are reconciled to the total obligations to be incurred during the year by estimating the buildup or decrease during the year of the resources that are to be applied to future years' operations. These estimates are included in the section titled, "Increase or Decrease (—) in Selected Resources" and include inventories and undelivered orders.

From total obligations are deducted the revenues estimated to be obtained from non-Federal sources in order to arrive at the amount of appropriations required. These revenues are obtained from the operations of AEC-owned communities and housing, from the sale of products, from services performed for others, and from other miscellaneous sources. These revenues are identified and summarized under the tab "Revenues applied."

The following table summarizes the accrued costs for each program, and the total obligations for fiscal years 1959, 1960, and 1961. The detailed justifications, beginning on page 14, present the programs in the same order as they appear on this summary table.

Summary of accrued operating costs by program reconciled to net obligations

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Accrued costs by program:			
Raw materials	$705,512,144	$728,646,000	$630,000,000
Special nuclear materials	541,303,455	563,000,000	567,700,000
Weapons	484,879,166	498,100,000	504,000,000
Reactor development	347,057,273	389,800,000	436,200,000
Physical research	114,645,885	143,344,000	163,200,000
Biology and medicine	42,007,757	49,000,000	54,200,000
Training, education, and information	13,033,893	13,500,000	14,200,000
Civilian applications of isotopes and nuclear explosives	5,762,397	11,000,000	11,500,000
Community	16,509,601	14,632,000	10,204,000
Program direction and administration	49,412,165	52,000,000	54,900,000
Security investigations	6,995,176	6,097,000	5,862,000
Other costs	5,559,672	5,800,000	6,500,000
Adjustment to prior-year costs	−3,483,142	0	0
Total accrued program costs	2,329,195,442	2,474,919,000	2,458,466,000
Changes in selected resources	18,265,361	54,058,420	28,434,000
Total obligations for operating expenses	2,347,460,803	2,528,977,420	2,486,900,000
Less revenues applied	28,079,323	26,850,000	22,600,000
Net obligations (financed by appropriated funds)	2,319,381,480	2,502,127,420	2,464,300,000

FINANCING OF OBLIGATIONS

The financing of the estimated total obligations of $2,486,900,000 proposed in the budget estimates for fiscal year 1961, together with comparable data for fiscal year 1959 and 1960, is summarized in the following table:

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Funds available for obligation:			
Unobligated balance beginning of year (reappropriation)	$77,990,252	$152,369,420	$37,000,000
Appropriation	2,397,406,000	2,389,114,000	2,427,300,000
Revenues received from non-Federal sources	28,079,323	26,850,000	22,600,000
Transfer to "Salaries and expenses," National Science Foundation (72 Stat. 881; 73 Stat. 364)	−2,000,000	−2,000,000	0
Comparative transfers to other accounts	−516,185	−356,000	0
1959 appropriation available in 1958—advance procurement (72 Stat. 98)	−1,129,167	0	0
Total funds available for obligation	2,499,830,223	2,565,977,420	2,486,900,000
Less: Unobligated balance, end of year	152,369,420	37,000,000	0
Total obligations incurred	2,347,460,803	2,528,977,420	2,486,900,000

Of the unobligated balance of $37 million estimated to be available at the end of fiscal year 1960, some $19 million reflects the difference between the actual unobligated balance on June 30, 1959, and the estimate of $133,100,000 included in the 1960 budget estimates.

EXPENDITURES FOR OPERATING EXPENSES

Expenditures from the operating expenses appropriation for fiscal year 1961 are estimated at $2,409 million, a decrease of $6 million from estimated expenditures of $2,415 million in fiscal year 1960. Actual expenditures for operating expenses in fiscal year 1959 totaled $2,326,200,129. The estimated amounts available for expenditure in fiscal years 1959, 1960, and 1961, the expenditures for each year, and the remaining unexpended balances are shown in the following table:

Expenditure analysis

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Funds available for expenditure:			
Unexpended balance, beginning of year:			
Obligated	$821,546,508	$815,244,044	$902,727,464
Unobligated balance	77,990,252	152,369,420	37,000,000
New appropriation	2,397,406,000	2,389,114,000	2,427,300,000
Transfer to "Salaries and expenses," National Science Foundation (72 Stat. 881; 73 Stat. 364)	−2,000,000	−2,000,000	0
1959 appropriation available in 1958—advance procurement (72 Stat. 98)	−1,129,167	0	0
Total funds available for expenditure	3,293,813,593	3,354,727,464	3,367,027,464
Less expenditures	2,326,200,129	2,415,000,000	2,409,000,000
Unexpended balance, end of year:			
Obligated	815,244,044	902,727,464	958,027,464
Unobligated balance	152,369,420	37,000,000	0
Total unexpended balance	967,613,464	939,727,464	958,027,464

HIGHLIGHTS OF OPERATING PROGRAMS

There follows a brief description of each of the programs set forth in the summary on page 2.

Operating costs

1. *Raw materials program.*—Operating costs for the raw materials program are estimated at $630 million in fiscal year 1961, compared with estimated fis-

cal year 1960 costs of $728.6 million and actual fiscal year 1959 costs of $705.5 million. The raw materials program includes the procurement of uranium concentrates and ores from foreign and domestic sources and related costs for resource evaluation. The decrease in quantities of uranium concentrates to be procured in fiscal year 1961 results primarily from the deferral of Canadian deliveries until after fiscal year 1962.

2. *Special nuclear materials program.*—Operating costs for the special nuclear materials program are estimated at $567.7 million in fiscal year 1961, compared with estimated fiscal year 1960 costs of $563 million and actual fiscal year 1959 costs of $541.3 million. The production of special nuclear materials begins with the refinement of uranium concentrates for diffusion plants or reactors. The isotope uranium 235 is extracted in gaseous diffusion plants at Oak Ridge, Tenn., Paducah, Ky., and Portsmouth, Ohio. Plutonium is synthesized in the reactors at Hanford, Wash., and Savannah River, S.C. Improvements in processes for each manufacturing step are aimed at decreases in unit costs, increases in yield and improvements in the quality of products.

3. *Weapons program.*—Operating costs for the weapons program are estimated at $504 million in fiscal year 1961 compared with estimated fiscal year 1960 costs of $498.1 million and actual fiscal year 1959 costs of $484.9 million. The weapons program includes the production of atomic weapons, the maintenance of stockpiled weapons in a state of constant readiness, the development and design of new weapon types, and the maintenance of test areas in standby or caretaker status.

4. *Reactor development program.*—Operating costs for the reactor development program are estimated at $436.2 million in fiscal year 1961 compared with estimated fiscal year 1960 costs of $389.8 million and actual fiscal year 1959 costs of $347.1 million. Emphasis will continue to be placed on advancing power reactor technology in order to achieve large scale generation of economic electrical energy from atomic reactors. Cooperative endeavors between the Commission and industrial groups, as well as with Euratom and Canada, will be stressed.

The estimates provide for general reactor systems research and development applicable to many reactor designs, fuel cycle development, a program of reactor safety, a program for development of separations systems for processing irradiated fuel elements, and development of systems for disposal of radioactive wastes.

Work will also be continued on reactors to propel merchant vessels, on reactors to meet military needs for power in remote areas, on reactors to propel naval vessels, military aircraft, and missiles, and on reactors to provide electric power and heat for satellites. This research also provides information useful in the development of civilian power reactors.

Operation of test facilities and experimental reactors will be continued at the National Reactor Testing Station, Idaho.

5. *Physical research program.*—Operating costs for physical research are estimated at $163.2 million in fiscal year 1961 compared with estimated fiscal year 1960 costs of $143.3 million and actual fiscal year 1959 costs of $114.6 million. The physical research program consists of theoretical and experimental investigations required to support both the Commission's immediate and long-range objectives for utilizing nuclear energy. Advances achieved in the past can be traced back to similar laboratory investigations. In the atomic energy program, research plays a relatively more important role than in other industrial operations of comparable size. The phenomena dealt with are close to the frontiers of science. Unusual materials are employed, and their nuclear as well as their chemical and physical properties must be determined. The temperatures and radiation densities at which these materials are used are outside the range of previous experience in industrial technology.

Research will be continued on the controlled thermonuclear project to eventually achieve production of power through the fusion process.

Research is carried on both by Commission laboratories and by some 140 universities and other independent institutions.

6. *Biology and medicine program.*—Operating costs for research in biology and medicine are estimated at $54.2 million for fiscal year 1961, compared with estimated costs of $49 million in fiscal year 1960 and actual costs of $42 million in fiscal year 1959. Primary program emphasis will continue to be placed on the protection of the health and safety of atomic energy plant workers and the general populace from the hazards of atomic energy operations. Research

on radioactive fallout problems and related research in the biological hazards of radiation will continue to be expanded. Additional emphasis will be placed on research efforts of pertinence in the rapidly growing field of industrial uses of atomic energy. Close liaison will continue to be maintained with the Office of Civil and Defense Mobilization as well as with other agencies performing functions interrelated with Commission biomedical interests. Research is carried on both by Commission laboratories and by some 220 universities and other independent institutions.

7. *Training, education, and information program.*—Operating costs for the training, education and information program are estimated at $14.2 million in fiscal year 1961 compared to estimated fiscal year 1960 costs of $13.5 million and actual fiscal year 1959 costs of $13 million. Primary program emphasis will continue to be placed on broadening the base of nuclear technology at home and abroad. Program efforts are directed toward the provision of assistance to colleges and universities in establishing nuclear curriculums; the provision of assistance to States for training in radiation control; the operation, through contract, of schools and the conduct of specialized courses; offering of graduate fellowships in the nuclear energy field; presentation of international conferences, studies and exhibits; and the development and dissemination of technical information.

8. *Civilian applications of isotopes and nuclear explosives.*—Operating costs for this program are estimated at $11.5 million in fiscal year 1961 compared to estimated fiscal year 1960 costs of $11 million and actual fiscal year 1959 costs of $5.8 million. The civilian applications of isotopes consist of research and development activities required to accelerate realization of the potentially vast nonpower uses of atomic energy. The program will provide for (1) expansion of the technology and utilization of isotopes with particular attention to industrial and commercial opportunities; (2) laying the foundation for training of persons who can work safely with radiation; (3) encouraging the private production of isotopes; and (4) developing, through research and development activities, application of high level or massive radiation.

The civilian applications of nuclear explosives program (Plowshare) encompasses the development of peaceful uses of nuclear explosives. The program provides for (1) development of special instrumentation and feasibility studies regarding new applications, (2) device development, (3) high explosive experiments in different media to obtain scaling and effects data, (4) experimental effort directed toward power and isotope production, and (5) experiments to obtain information on the use of nuclear explosives for excavations.

9. *Community.*—The Commission will continue to operate under contract the community of Los Alamos, N. Mex., and provide limited housing services at other locations. The communities of Oak Ridge, Tenn., and Richland, Wash., are being disposed of under the Atomic Energy Community Act of 1955, as amended, and the estimates assume that transfer of all facilities will have been effected by the end of fiscal year 1960. The fiscal year 1961 estimates for Oak Ridge and Richland consist only of assistance payments to the newly organized community groups, as authorized by law and minor closeout costs. Estimated costs of $10.2 million will be incurred in fiscal year 1961 for community operations compared with estimated fiscal year 1960 costs of $14.6 million and actual fiscal year 1959 costs of $16.5 million.

10. *Program direction and administration.*—Under the general heading of program direction and administration are grouped together the salary costs and other expenses of Commission personnel engaged in general management, executive direction, and technical supervision of program operations; the negotiation and administration of contracts; and other related administrative activities. The corresponding costs for Commission personnel engaged in nonadministrative activities directly related to a specific program are included in that program, as for example, personnel safeguarding classified shipments or providing fire protection for a community. Expenses of personnel of other Government agencies, including their travel, doing work for the Commission are treated as contractual services, are not included in the AEC detail of personal services and travel, and are not included in limitation amounts.

Estimated costs of $54.9 million will be incurred in fiscal year 1961 for program direction and administration compared with estimated fiscal year 1960 costs of $52 million and actual fiscal year 1959 costs of $49.4 million. An increase of 100 employees is budgeted under this program in fiscal year 1961. The increase of $2.9 million provides for salaries, travel, and other costs associated with the higher average employment, and other special requirements,

including, for the first time, the cost of the Federal Employees Health Benefit Act of 1959. The costs in fiscal year 1961 represent 2.2 percent of total operating costs, compared with an estimated 2.1 percent in fiscal years 1960 and 1959.

11. *Security investigations.*—Costs of security investigations in fiscal year 1961 are estimated at $5.9 million compared with estimated fiscal year 1960 costs of $6.1 million and actual fiscal year 1959 costs of $7 million. Under provisions of the Atomic Energy Act of 1954, persons to be employed on work involving access to restricted data are required to be cleared for security purposes based on investigations by the Civil Service Commission or the Federal Bureau of Investigation.

12. *Other costs.*—This program includes costs incurred by the Commission in furnishing materials and services to industrial organizations and other private parties apart from those which it provides normally for its own basic program. The costs are incurred only upon the request of others. Charges are made for these materials and services and the revenues derived are included under "Revenues applied." Other costs are estimated to be $6.5 million in fiscal year 1961, compared with $5.8 million in fiscal year 1960 and $5.6 million in fiscal year 1959. The higher estimate in fiscal year 1961 is due principally to an estimated increase in sales of radioisotopes.

13. *Selected resources.*—This program includes inventory stocks held by the AEC and its contractors, collateral funds, and goods and services on order under contract. The appropriation requirements for these items are based on the changes in balances from the previous fiscal year. Selected resources at the end of fiscal year 1961 are estimated at $964.4 million as compared with $936 million in fiscal year 1960 and $881.9 million in fiscal year 1959. The increase of $28.4 million in fiscal year 1961 is related principally to: (1) an increase in balances related to procurement of Canadian uranium concentrates, delivery of which is deferred until future years; and (2) an expanded research and development effort on the reactor development and weapons programs.

Fiscal year 1960 balances include $13.6 million for a computer for the Lawrence Radiation Laboratory which is required for increases in the computational load as a result of the intensive weapons effort at that location. The computer is expected to be delivered in fiscal year 1962. This increase for the computer was offset by a reduction in a like amount for irradiation test space contracts determined to be in excess of the amount of the currently estimated need for such contracts.

14. *Revenues applied.*—This program includes (1) income from sales and lease of products, and services rendered, (2) revenues from communities and (3) other miscellaneous income items. These revenues are applied against Atomic Energy Commission appropriation requirements. Revenues are estimated at $22.6 million for fiscal year 1961, compared to an estimate of $26.9 million for fiscal year 1960, reflecting a decrease of $4.8 million in community revenues, partially offset by a net increase in other revenues of $0.5 million. Revenues for fiscal year 1959 were $28.1 million.

U.S. Atomic Energy Commission

JUSTIFICATION FOR PROPOSED LANGUAGE CHANGES—OPERATING EXPENSES

The proposed changes in the appropriation language for Operating expenses are described below. Language enclosed in black brackets indicates proposed deletions; language in italic indicates proposed insertions.

1. "not to exceed [$3,550,000] *$3,650,000* for expenses of travel;".

This change is in accordance with the estimated requirements in fiscal year 1961 for expenses of travel as set forth in the detailed estimates.

2. "not to exceed [$52,750,000] *$53,600,000* for personal services;".

This change is in line with the estimated requirements in fiscal year 1961 for personal services as set forth in the detailed estimates.

3. "purchase (not to exceed [three hundred and ninety-six] *four hundred and sixty*, of which [three hundred and sixty-six] *four hundred and thirty-seven* are for replacement only, including [one] *two* at not to exceed $4,000 *each*) and hire of passenger motor vehicles;".

This provides authorization for the procurement in fiscal year 1961 of 460 passenger motor vehicles of which 437 are required for replacement of older vehicles and 23 would be additions to the fleet. The vehicles being replaced are eligible for replacement under the standards established by the General Services Administration. Included in the number to be replaced are two

passenger motor vehicles for use at headquarters to provide transportation for the AEC Commissioners to and from official meetings in Washington. They will replace similar vehicles currently eligible for and requiring replacement. The General Government Matters Appropriation Act for fiscal year 1960 (Public Law 86–79) establishes a limitation of $1,500 on the cost of a passenger motor vehicle unless otherwise specifically provided. The proposed language would authorize the procurement of these two vehicles at a cost of not to exceed **$4,000 each.**

For the past several years the Commission has been reducing the number of passenger motor vehicles being operated. Contractors are assigned passenger motor vehicles as Government-furnished equipment and operate them in carrying out the Commission's program. In the light of the increased programs being carried on, it will be necessary to provide increased numbers of vehicles at various locations. Of the additional vehicles being requested, seven are required at Hanford in connection with the construction of the new production reactor; three will be required at the Argonne National Laboratory and eight at the Brookhaven National Laboratory to meet the laboratories' needs resulting from the expanding program and facility additions; and eight will be required at the National Reactor Testing Station, Idaho, because of the expanded operations at that site. Offsetting these additions will be a reduction of three vehicles at the Albuquerque operations office. With the net addition of 23, the fleet will number 2,044 at the end of 1961.

4. "[$2,389,114,000] *$2,427,300,000, which*, together with the unexpended balances, as of June 30, [1959] *1960*, of prior year appropriations made available under this head to the Atomic Energy Commission, and [, in addition,] any moneys (except sums received from disposal of property under the Atomic Energy Community Act of 1955 (42 U.S.C. 2301)) received by the Commission, notwithstanding the provisions of section 3617 of the Revised Statutes (31 U.S.C. 484), *shall remain available until expended:*".

This change provides (1) for insertion of the amount requested to be appropriated for fiscal year 1961, (2) for continuing the provision making unexpended balances available in the new year which has been in effect since 1950, and (3) for establishing the "Operating expenses" appropriation as a no-year appropriation, to be available until expended.

5. "[That of the funds appropriated herein, $2,000,000 shall be transferred to and merged with funds appropriated to the National Science Foundation: Provided further,].

"[*Provided further*, That in the event the Commission deems it desirable to design and construct at a Commission installation any power reactor prototype for which cooperative arrangements are authorized under the Commission's authorization Act for the fiscal year 1960, as part of the cooperative power reactor demonstration program, and for which direct construction by the Commision is authorized as an alternative to a cooperative arrangement, not to exceed $16,000,000 of the amount appropriated herein may be transferred to the appropriation for "Plant acquisition and construction"]".

These changes eliminate language for which there is no requirement in fiscal year 1961.

JUSTIFICATION FOR PROPOSED LANGUAGE CHANGES—GENERAL PROVISIONS

The proposed change in the language for the administrative provisions is described below. Language enclosed in brackets indicates proposed deletions; language in italic indicates proposed insertions.

1. "Any appropriation available under this or any other Act to the Atomic Energy Commission may initially be used subject to limitations in this Act during the fiscal year [1960] *1961* to finance the procurement of materials, services, or other costs which are a part of work or activities for which funds have been provided in any other appropriation available to the Commission: * * *"

This change makes the provision applicable to fiscal year 1961.

General Statement

Mr. Cannon. Mr. Chairman, we shall be glad to have a statement from you at this time.

Mr. McCone. Mr. Chairman and members of the committee, it gives us great pleasure to meet with you today to outline the budget

estimates of the Atomic Energy Commission for the fiscal year 1961.

Before proceeding with the presentation, Mr. Chairman, I would like to introduce to the comittee our newest Commissioner, Dr. Robert E. Wilson. As you know, Dr. Wilson has had a distinguished career as industrialist, scientist, and inventor, and almost from the beginning of the Atomic Energy Commission has served on various advisory committees to the Commission, most recently on the GAC by appointment from the President, but he resigned from that Committee in order to accept appointment to the Commission.

I should like to point out, Mr. Chairman, that some portions of my statement contain classified information. Copies of the document we have placed in the hands of members of your committee, therefore, bear appropriate markings to indicate that they contain restricted data. With your permission, Mr. Chairman, I would propose to read my statement in its entirety, but with the understanding that certain portions would be amended or deleted altogether from the transcript so as to provide an unclassified statement for the printed record.

Mr. CANNON. Mr. Chairman, when your transcript comes to you and to the Commissioners, please feel free to delete any material you think should be eliminated in the interest of national defense.

Mr. MCCONE. Thank you; we will do that.

Mr. CANNON. I might also say, please feel free to elaborate on any statement in order to make it more precise.

You may proceed.

Mr. MCCONE. As you know, funds for the atomic enery program are provided in two appropriations, one for operating expenses and one for plant acquisition and construction. Our requested appropriation for operating expenses is $2,427,300,000. For plant acquisition and construction we are requesting a fiscal year 1961 appropriation of $215,500,00.

Our 1961 estimates closely resemble those of recent years. Activities related to military requirements constitute the major portion of the total budget. These activities include development work on military reactors, and the development and manufacture of nuclear weapons. Also identified with military requirements are the costs of procuring raw materials and converting them to uranium 235, plutonium, and other weapons materials.

RAW MATERIALS

I shall discuss first the raw materials program. Raw material costs are estimated at $630 million in fiscal year 1961, a decrease of $100 million from 1960. This still is the largest single item in the Commission budget, accounting for more than 25 percent of the total estimated 1961 operating cost.

Both domestic production of uranium concentrates and our proven reserves continued to increase during the past year. As a result of deferrals negotiated with some of the major producers, domestic production is expected to hold at about the current level for the next 2 years. Deliveries from overseas also are likely to remain near the 1960 level.

The $100 million reduction in our fiscal year 1961 submission is largely the result of a stretchout agreement reached last November

with the Canadian Government. Approximately 4,900 tons of Canadian concentrates, which otherwise were scheduled to be delivered in fiscal year 1961, are estimated to be deferred until after fiscal year 1962, when the majority of our Canadian contracts otherwise would expire.

Giving effect to the estimated Canadian and domestic deferrals, projected receipts of U^{308} in 1961 will total about 31,800 tons as compared with 35,300 tons in 1960, a 10 percent reduction. Of these estimated 1961 receipts 58 percent will be from domestic suppliers, 28 percent from Canada, and 14 percent from oversea sources.

Total 1961 costs of the raw materials program show a decrease of 14 percent compared with 1960. This reduction is due not only to the decrease in total deliveries but also to the continued decline in the average price per pound paid for uranium concentrates from $10.09 to $9.77.

Our efforts during the past few years to limit additional domestic procurement and to negotiate stretchout arrangements with both domestic and foreign suppliers are bringing near-term deliveries more in line with projected requirements. The deferred quantities will be delivered following fiscal year 1962, when there otherwise would be a sharp drop in receipts.

It should be noted that the deferrals anticipated in the budget were based on preliminary negotiations. To the extent that these deferrals are not realized, additional amounts may be required to fund deliveries.

The Commission's total commitments under foreign and domestic contracts and domestic public announcements for the period July 1, 1960, through December 31, 1966, are for approximately 162,000 tons of uranium concentrate estimated to cost about $2,925 million.

I would like to state, Mr. Chairman, that the deferrals which I have been discussing do not involve an increase in our total commitment. They merely postpone the acceptance of deliveries until after the 1962 period.

SPECIAL NUCLEAR MATERIALS

Next in our budget presentation is the special nuclear materials program. While 1961 receipts of uranium concentrates for processing into feed materials to be used in the production of uranium 235 and plutonium will be at the reduced rates previously mentioned, the feed materials supply will be adequate to meet weapons production schedules, the needs of other military programs, and the requirements for peaceful uses of atomic energy.

With respect to participation by private industry in the processing of uranium for the AEC production program, we can report that the privately financed Allied Chemical Corp. plant has completed its first year of operation and is currently able to meet the contractual production rate for specification uranium hexafluoride feed for our gaseous diffusion plants. Also, we are now planning to invite private industry to participate in the processing of uranium metal feed for the new Hanford production reactor.

(Discussion off the record.)

Mr. McCone. It might be noted that, the new production reactor at Hanford, the construction of which is proceeding in accordance with the schedule, will start up in fiscal year 1963.

Production of other special materials needed for both military and civilian applications will be at rates necessary to meet schedules in the most economic manner.

In the absence of a privately owned chemical processing plant the AEC has been planning to process in AEC installations irradiated fuels from civilian reactors. During the past several months, the Commission has learned of a current interest within private industry in providing chemical reprocessing services as a commercial venture. We expect to be advised as to industry's conclusions on this matter after the completion of studies now underway. Accordingly, we have postponed action on plant modifications for the processing of these materials until early next fiscal year.

Emphasis in process improvement efforts will continue to be placed upon assuring continuity and safety of operations and the achievement of more economical production methods.

WEAPONS

In the weapons program the funds requested would continue production of such types, and numbers, of bombs and warheads as have been stated to us by the Department of Defense as being required. These funds would also carry on at about the same rate as in earlier years related storage and surveillance functions. They would continue an active research and development program to improve existing designs and to bring forth new designs to the limit that our current situation permits. They would provide for the holding of the nuclear proving ground in an inactive status, but without funds for any nuclear weapons tests. I would like to describe briefly some factors concerning our test situation and our research and development efforts.

(Discussion off the record.)

Mr. McCone. As I mentioned earlier, we have budgeted no funds in fiscal 1961 for the carrying out of nuclear weapons tests. Through a major portion of fiscal year 1960, we have maintained the Eniwetok Proving Ground on a standby basis at a cost approximating $600,000 per month. We are now developing plans to change over to an inactive caretaker status, and therefore have programed only $2 million for caretaking during fiscal year 1961. At the Nevada test site, during this current fiscal year and the year preceding, we carried on certain tunnel work and procurement of long leadtime items with the objective of being ready to test underground there a limited number of devices should authority so to do be given. This budget makes no provision for further weapon test preparatory work in fiscal year 1961 but we shall retain the Nevada test site and the preparations we have made on a standby basis. The test site and its administrative facilities will be used during fiscal year 1961 for ROVER and PLUTO test activities.

In the field of research and development, our inability to conduct nuclear tests will restrict materially our future ability to come forth with new and different designs and to prove rapidly their reliability and safety. The moratorium to date has been used by our laboratories in digesting information secured from past tests and in developing for stockpile proven designs required for our national defense. As you know, it now appears likely that the moratorium will go further, provided agreement is reached under the conditions laid down by the

President and the Prime Minister in their statement of March 29, 1960. During this period we can make some progress on improving, and extrapolating from, existing designs. Faced by this situation, we believe it imperative that we continue the energetic program of our critical weapon laboratories, and accomplish through research and development such advances as are possible of accomplishment in the absence of testing.

Naturally, if we are to adopt improved or extrapolated designs which we have not tested, we must be certain as to their reliability and their safety. To do this requires much more elaborate theoretical analyses than were needed when tests were possible to check new designs. It requires a tremendously increased computational load in connection with these analyses. It requires more elaborate nonnuclear testing of components and firing of high explosive assemblies.

We do not intend during this fiscal year to increase the number of personnel working on weapons in our three nuclear weapon laboratories. However, to enable them to function most effectively under these new conditions necessitates a proportionally small increase in nuclear and nonnuclear research and development costs over earlier years. The funds requested for these two activities have been increased somewhat, therefore, over fiscal year 1960 expenditures. Importantly, too, to meet the added computational load, we are proceeding to purchase additional computer capacity for the Lawrence Radiation Laboratory, Livermore Branch, as has already been done for the Los Alamos Laboratory.

As a last point and one related to the test moratorium, I would like to point out that we are carrying on certain activities related to improving test detection systems. A major portion of the work can be handled better by other agencies, so our activity in this regard is that for which we are uniquely qualified. In the field of detecting high altitude detonations, we have expended approximately $2 million during fiscal year 1960 in development of instruments for use in satellites. We have purchased, also, one set of instruments to examine the possibility of detecting shots in lower space from ground stations. We have carried out a series of high explosive detonations in large cavities to examine whether such emplacement would muffle the seismic signal essential to detecting underground shots. Also, we have underway in connection with our test readiness program at the Nevada test site, construction of a shaft wherein we could—subject to national policy—detonate a nuclear charge in a different rock strata to examine how the strata change affects the seismic signal.

REACTOR DEVELOPMENT

The Commission's reactor development program covers the entire range of activities directed to meeting reactor requirements for military and space applications and to reducing the cost of generating electricity and heat from nuclear energy for civilian purposes. In total these efforts are estimated to cost about $436 million in fiscal year 1961.

CIVILIAN POWER

The civilian power program has been given concentrated attention during the past year, and significant results can be reported. Ex-

tending the program studies described to you last year, the Commission undertook a comprehensive analysis to provide a basis for long-range plans for the civilian power reactor program. The information assembled deals with the current status of the technology for each of the reactor design concepts on which we have been working, appraises their economic potential, and outlines future development plans.

These initial reports and the program we have now formulated represents only a first step in a projected systematic effort to evaluate and reappraise our goals, opportunities, and accomplishments on a continuous basis. We must be alert to recognize the significance of new information in this growing technology, so that we can take prompt advantage of unforeseen opportunities, on the one hand, and, on the other, so that we can eliminate effort on projects which are no longer fulfilling their earlier promise.

Our goals for civilian reactor development are substantially unchanged from those widely agreed upon last year. We seek to reduce the cost of nuclear power from large central stations to levels competitive with power from fossil fuels in the high cost areas of this country by 1968, and thereafter to achieve further reductions which will increase these economic benefits and extend them to wider areas. A still longer range objective is to develop power reactors capable of breeding nuclear fuel, in recognition that the naturally occurring isotope, uranium 235, may not alone be sufficiently plentiful to meet foreseeable needs in the long-range future. In all these efforts it is our purpose to maintain this Nation's position of leadership in the technology of nuclear power.

To achieve competitive costs for nuclear power requires us to emphasize the development of technology for large-scale central-station plants. Much of this technology also has application to smaller size plants, and we shall continue to support projects directed specifically to reducing the cost of nuclear power produced in small plants.

Turning now to our proposed program for fiscal year 1961, the Commission will continue general research and development which feeds new technology to all reactor projects, both civilian and military. These efforts include the development of improved reactor materials, components, instrumentation and controls, and the investigation of systems for radioactive waste disposal. Activities which will receive increased emphasis in 1961 are the exploration of advanced design concepts useful for both large and small reactors, and the development of improved reactor fuels and systems for fuel recovery.

Our existing facilities in Idaho for irradiation testing of fuels and reactor components are being supplemented in several ways to meet needs now clearly foreseen. Year to year contracts are being negotiated for test space in privately owned testing reactors of General Electric Co. and Westinghouse Electric Corp. We would also expect, under appropriate long-term contractual arrangements, to use space in a privately owned testing reactor proposed for construction by the Babcock & Wilcox Co. Certain other irradiation requirements for high performance naval and power reactors can be met only by an advanced test reactor capable of providing much higher neutron fluxes than are available from existing or proposed privately owned testing

reactors. The Commission proposes in 1961 to start construction of such a high flux reactor.

In the work directed to developing the most promising design concepts for civilian power reactors, we will continue to construct, modify, and operate reactor experiments. During fiscal year 1961 the AEC expects to have in operation nine reactor experiments, of which four will be started up for the first time during that year. The latter group consists of a boiling water reactor experiment and an experimental fast breeder reactor now under construction at the National Reactor Testing Station in Idaho, and reactors under construction at Hanford for development of a plutonium fuel cycle and at Savannah River for the development of components for heavy water reactors. In addition, two experimental reactors will be under construction, the experimental gas-cooled reactor at Oak Ridge and the experimental organic-cooled reactor at the National Reactor Testing Station.

The Commission-owned prototype pressurized water reactor plant at Shippingport will also continue in operation in 1961. Certain modifications are planned which will permit the full power testing of the second reactor core at a power level of 150,000 equivalent electrical kilowatts, more than double the 60,000 kilowatt rating of the first core. Negotiations were conducted earlier this year between the Commission and the Duquesne Light Co. concerning installation of electrical generating capacity which would use the increased amount of steam to be produced. Both the Commission and Duquesne subsequently agreed that it would not be economical to install additional turbogenerator capacity, but that it would be more practical to dissipate the steam by means of a heat sink, for which the Commission is requesting funds in this budget.

To prove out the conclusions tentatively drawn from the operation of reactor experiments, it is essential in the development of each reactor concept to construct and operate prototype reactors. It is the Commission's strong preference that prototype plants be built and operated by publicly or privately owned utilities. To encourage industry to undertake such projects, and to maximize the technological gains, the Commission is prepared to participate in such ventures through cooperative arrangements. Under so-called second round arrangements, suitable for cooperative and publicly owned utilities, AEC's participation includes both research and development work and construction of the reactor, while the operating utility provides the electric generating facilities. Under third-round arrangements, AEC limits its participation to research and development and waiver of use charges for fuel and heavy water; all construction costs are borne by the utility.

Should industry proposals not be forthcoming for a prototype plant considered by the Commission to be an essential step in the orderly development of a particular reactor concept, the Commission would undertake to construct the plan with Government funds.

During fiscal year 1961, under cooperative arrangements now in effect, we expect four prototype reactors to come into operation and an additional five or six to be under construction.

In addition, proposals have been invited or received for four other cooperative power reactor projects for which the detailed arrange-

ments remain to be worked out. The review of factors bearing on the safety aspects of proposed sites is a major problem in the consideration of such proposals. For 1961 we anticipate a substantial increase in the portion of our civilian power reactor effort being carried out under cooperative arrangements.

The final stage in the development of a particular power reactor concept is the construction of large, commercial size nuclear powerplants. Primary responsibility for undertaking projects in this category lies with the utility industry.

Industry has undertaken five power reactor projects which are wholly financed with private capital, including related research and development. These projects include two small experimental reactors, the intermediate size Humboldt Bay boiling water prototype plant, the large size Dresden boiling water plant, and the large pressurized water plant at Indian Point. A highlight of the past year was the completion and initial startup of the Dresden plant; operation at its design power level of 180,000 electrical kilowatts is expected later this year. The Dresden plant went on line April 15, reaching 65,000 kilowatts (electrical) on April 18, and is expected to reach 90,000 kilowatts today. The information gained from these projects will be of immense value to the civilian power program.

Today it appears that the time may be nearer at hand than 1968 when a large-scale nuclear powerplant can be undertaken by a utility company on the basis that during the plant's useful life it will prove more economical than a powerplant using conventional fuel. Leading reactor manufacturers have publicly offered to construct large-scale power reactors on the basis of a fixed price which is low enough to attract substantial interest on the part of the major utilities operating in areas of high-cost power such as California. It would be of significant benefit to the Commission's program to have one or more such large-size plants constructed and operated. It is possible that during the coming year, under its authorization to grant research and development assistance and to waive certain fuel-use charges in connection with unsolicited proposals, the Commission may find it appropriate to encourage one or more utility companies to undertake the commitments involved in building such a large-scale nuclear powerplant.

INTERNATIONAL COOPERATION

The Commission's program for cooperation with other countries and international organizations in the peaceful uses of atomic energy is carried out, for the most part, by making available the information developed in the Commission's various activities, and by providing unique materials, equipment, services, advice, and opportunities for training of personnel.

In addition to this broad program of assistance, the Commission also has undertaken to participate with other countries in specific projects which would be beneficial to our own reactor development program. The first such project was the joint reactor program with Euratom, which had as its goal the construction, within the six member countries, of 1 million electrical kilowatts of power reactor capacity within the next several years.

Largely because of an improvement in the prospects for fossil fuel supplies during the next decade or so, the construction and opera-

tion of nuclear power reactors is now regarded by the industrialized nations of Western Europe as less urgent than appeared to be the case when the timetable for Euratom nuclear power projects was formulated 2 years ago. As a result, only one firm proposal for construction of a nuclear powerplant under the joint United States-Euratom program has been submitted, the SENN project in Italy. Other proposals may yet mature and be found acceptable, but it is clear that the scope and pace of the Euratom nuclear power program will be considerably reduced compared with earlier expectations.

For many years our cooperative endeavors with Canada have included the exchange of research and development results relevant to heavy water moderated power reactors. Canada's interest in this type of reactor has progressed to the point of planning to construct a large power reactor, for which a smaller prototype is already under construction. Rather than pursue a parallel course which would largely duplicate Canadian efforts, the Commission proposes to participate in the development work associated with the Canadian project and thereby obtain, for use by the U.S. industry, all information which would be necessary for industry to construct a similar project in the United States.

MILITARY AND SPACE REACTORS

More than half of the total estimated operating costs for our reactor development program is for projects to meet the requirements of the Department of Defense and the National Aeronautics and Space Administration. Propulsion requirements range over wide areas: from combat ships to rockets for space. Heat and power requirements range from those for remote military installations to those for auxiliary systems of satellites.

Last July our program for the development of propulsion reactors for manned aircraft was reoriented. The revised program places increased emphasis on the development of materials and reactor systems capable of high performance and long life. As you know, we are working on two approaches—the indirect cycle and the direct cycle—to meet the common objective of a high performance propulsion system. In both approaches there are challenging problems to be met in reactor physics, high temperatures, corrosion, radiation resistant materials, and shielding; problems with are, of course, important to our entire reactor development program—both military and civilian. Both approaches show promise of useful application.

The indirect cycle approach uses solid fuel elements to heat a liquid metal coolant. This heat is transferred from liquid metal to air by a radiator which serves in place of the chemical combustion section in a turbojet engine. This system offers potential applications ranging from subsonic planes to all-nuclear, supersonic, strategic bombers.

(Discussion off the record.)

In the direct cycle approach, air is heated directly by passage through the reactor. The effort in this approach consists of material, component, and reactor research and development. Tests in a series of reactor experiments have shown that ceramic homogeneous systems offer great promise.

(Discussion off the record.)

PROJECTS ROVER AND PLUTO

In the areas of missile propulsion reactors our effort consists of two projects: ROVER and PLUTO. Major emphasis in each has been on the development of materials for high-temperature, high-power-density reactors. Substantial growth in both projects is planned for 1961.

The purpose of Project ROVER is to demonstrate the feasibility of nuclear propulsion for rockets. The AEC and NASA are both working on the project. AEC's responsibility is the development and ground testing of the reactors, while NASA is responsible for the flight test system development and operation and is planning to construct the facilities required for this purpose.

For Project PLUTO our objective is to demonstrate the feasibility of nuclear ramjet engines for use in high-speed, low-altitude strategic-bombardment missiles. The first core test reactor experiment will reach criticality in the first half of fiscal year 1961. ———

Nuclear energy has its place in space exploration not only for propulsion but as a source of power for instrumentation of satellites and space vehicles. The designation of the AEC program for such auxiliary power is SNAP, short for systems for nuclear auxiliary power. The development of SNAP devices is concerned with problems peculiar to space environment which include those imposed by weight limitations and the requirement for long-term, reliable operation in the space environment.

The Commission recognizes that the introduction of nuclear devices into the space environs introduces new and unique potential health and safety problems. NASA, AEC, and DOD have established a joint committee to study these problems, and in addition AEC has established an Aerospace Nuclear Safety Board to review these problems in detail and make recommendations to the Commission.

Two types of power sources are under development. One is the radioisotope unit which uses the nuclear decay energy from an appropriate radioisotope. For larger amounts of power we are developing compact reactors as the heat source. Operation of such a reactor was announced last November. These heat sources can be used with static as well as rotating machinery for generating electrical power. Associated rotating equipment is also under test.

The SNAP program was originated to provide auxiliary power sources for the Air Force advance reconnaissance program and later for the NASA. The success of the SNAP devices has given impetus to further development of advanced SNAP systems to meet other requirements for long-lived, unattended electrical power sources——— An increase in 1961 is also projected for the SNAP effort.

NAVAL REACTORS

The objective of the naval reactors program is the development of nuclear propulsion plants and long-life reactor cores in a wide range of power ratings to meet the military requirements of the Department of Defense.

The Navy's authorized nuclear-powered-ship construction program through fiscal year 1960 includes 37 submarines and 3 surface ships.

By the end of calendar year 1960, the Navy expects to have 17 nuclear-powered submarines in operation. Of these 17 submarines, 5 are POLARIS missile firing submarines; 10 are attack submarines; 1 is a REGULUS missile firing submarine; and 1 is a 2-reactor radar picket submarine.

For fiscal year 1961 a substantial increase is projected in the research and development effort for naval reactors. I would like to say that there will not be an appreciable increase in our total expenditure to the field of naval reactors. There will be an increase in research and development, and a corresponding decrease in the supplying of materials because we do not have as many projects under construction.

Principal emphasis will be placed on the development of reactor cores having significantly longer life, the development of a nuclear propulsion plant for a nuclear-powered destroyer, and the development of a natural circulation reactor plant for submarine application. The land prototype for the destroyer reactor plant is now under construction at the Atomic Energy Commission's site located at West Milton, N.Y. Construction of the land prototype of the natural circulation reactor plant will be underway during fiscal year 1961.

ARMY REACTORS

The objective of the Army reactor program is to develop various reactor systems to fulfill military requirements for nuclear powerplants at remote locations. To meet this objective the powerplants must be compact, lightweight, and capable of being set up rapidly and at minimum costs. Four general concepts—pressurized water, boiling water, gas cooled, and fast reactor systems—are under development.

Small power reactors of the pressurized water and boiling water types are now operating. The major effort for these reactor types is to improve plant reliability and component systems, to reduce capital costs, to lower operating costs, and to provide basic and advanced knowledge for plants of these types now being planned or under construction for the military services.

During recent weeks a study authorized by Congress last year was completed by contract of the technical and economic feasibility of small power reactors which could be built with today's technology for various military applications at remote sites. The study indicates, on the basis of capital costs determined by the contractor and as yet unsupported by firm bids, that at selected sites to which delivery of conventional fuel is very costly, small power reactors offer economic advantage. Reactors appear to offer long-range advantage in Antarctica, for example. The Commission will welcome the opportunity to cooperate with any of the military services which may decide to procure and install power reactors for such remote sites.

Turning to longer range development objectives, for the gas-cooled concept our aim is to develop a mobile, trailer-mounted nuclear powerplant. The gas-cooled-reactor experiment to provide design and engineering data went critical in February of this year.

(Discussion off the record.)

MARITIME REACTORS

The program for the development of nuclear propulsion for merchant ships is the joint responsibility of the AEC and the Maritime Administration. Generally, the AEC has the responsibility for the nuclear portion of the program.

A pressurized water reactor is to propel the *Savannah*, the world's first nuclear-powered ship designed for commercial operation. The ship will be undergoing extensive testing this fall, and upon completion of testing, will be placed in operation. Thereafter, it will provide practical knowledge of the problems of maintenance, repair, and refueling, and of commercial supporting facilities needed for nuclear merchant shipping.

A gas-cooled reactor coupled to a closed cycle gas turbine appears to offer long-range promise for a high efficiency, light weight, low cost, compact propulsion system. During fiscal year 1961 we will continue the design work on major components and place in operation a critical experimental facility.

Design and engineering studies were recently completed on various reactor systems for a tanker of about 43,000 deadweight tons. The systems studied were the direct cycle boiling water reactor, the indirect cycle boiling water reactor, and the advanced pressurized water reactor. While the studies provide a basis for economic comparison, many factors such as today's depressed maritime market influence the maritime aspects of the study. Costs shown in the study should be considered as comparative only, and not as absolute.

PHYSICAL RESEARCH

Next in our budget is physical research, which is concerned with achieving a basic understanding of matter and energy. Included in physical research are the fields of high energy physics, chemistry, metallurgy, nuclear physics, mathematics, and controlled thermonuclear research. About two-thirds of the cost for this program is for research at AEC-owned major research centers, with the remaining cost associated with research at educational institutions, nonprofit research institutions, industrial laboratories, and other Government agencies.

The increase in the cost level for physical research is primarily attributable to high energy physics; a field which is aimed at furthering man's knowledge of the fundamental particles which make up matter. Research in this field has shown an increasing need for machines to produce particles of higher and higher energies and for more complex apparatus to accomplish the difficult measurements required.

The major AEC accelerators already operating in the multibillion-electron volt energy range are the cosmotron at Brookhaven National Laboratory and the bevatron at the Lawrence Radiation Laboratory in Berkeley. Four major accelerators are presently under construction. The 30 Bev. alternating gradient synchrotron at Brookhaven is nearing completion and initial operation is planned for the summer of 1960. The high intensity, 3 Bev. Princeton-Pennsylvania proton accelerator and the 6 Bev. Cambridge electron accelerator are ex-

pected to undergo tune-up tests in the latter part of fiscal year 1961, and in the following year we expect completion of the 12.5 Bev. zero gradient synchrotron at Argonne National Laboratory.

The pending authorization bill provides for modifications of the zero gradient synchrotron, the Princeton-Pennsylvania proton accelerator and the bevatron. These modifications will provide a greater capability for accommodating more advanced experiments. Also provided in the bill is a new project, the linear electron accelerator at Stanford University. The bill provides for initial design and engineering for a total of $3 million. The estimated project cost is $107.2 million. The funding for this authorization and for necessary research and development are not included in this budget. Appropriate estimates would be transmitted to the Congress after favorable action on the authorization bill.

The Commission is aware that the construction, modifications, and operation of these machines involves large sums, and that the cost will grow substantially in future years. Nevertheless, the Commission believes, after extensive reviews at high levels of Government, that this expense is justified by the importance of high energy physics in the Nation's total endeavor in basic research.

Controlled thermonuclear research will continue at about the same level as in recent years at four of the major AEC laboratories. However, there will be a decrease in the total cost level attributable to a drop in costs associated with design, fabrication and testing of the model C Stellarator. Controlled thermonuclear research offers promise for abundant cheap power, but practical results cannot be expected until a number of basic technical problems have been overcome which in our opinion will require many years of research.

BIOLOGY AND MEDICINE PROGRAM

Biomedical research is of vital importance not only to the continued successful operations of the Commission, but to the health and safety of the entire world in the nuclear age we have entered.

For the past several years, through the support of your Committee, we have been intensifying our research activities in radiation effects, fallout studies, and utilization of atomic energy and its tools and by-products in the biomedical and agricultural sciences. This broad program of research is essential to our health and safety and must continue at an increasing pace.

To improve our techniques for estimating radioactive contamination of the atmosphere and controlling the resulting hazards, it is essential to make full use of our present opportunity to study the radioactive debris from past tests which is still present in the upper atmosphere.

In order to achieve the increased pace during fiscal year 1961 which we consider essential, $54.2 million for biomedical activities is needed, an increase of 11 percent over 1960 costs. The greater part of this increase is for studies of radiation effects on biological systems, and biomedical problems in atomic energy operations.

The program for fallout studies during fiscal year 1961 has been reoriented to studies of a longer range character of the transport and ultimate fate of fallout. Less emphasis will be placed on the surveillance type of monitoring because this is now being undertaken on an

expanding basis by the Department of Health, Education, and Welfare.

The problem of fission product toxicity becomes more pressing and work on this aspect of the program will grow in fiscal year 1961. During the past year, certain observations have been made on the production of genetic effects and cancer by radiation, pointing to a lesser effect at low dose rates. These observations must be extended as rapidly as scientific manpower becomes available. The increased costs during 1961 for exploiting the beneficial uses of atomic energy will extend efforts in biological and medical applications, including the experimental treatment of cancer, using the medical reactor at the recently completed Brookhaven National Laboratory medical center and the 184-inch cyclotron at the Lawrence Radiation Laboratory in Berkeley.

An additional $4 million is needed for new facilities or for expansion or improvement of existing facilities primarily for use in updating our information on radioactive fallout and associated effects and hazards.

TRAINING, EDUCATION, AND INFORMATION

The training, education, and information program is designed to broaden the base of nuclear knowledge at home and abroad. Program effort includes equipment grants, materials, and teaching aids for colleges and universities; special courses conducted through contractors; graduate fellowships; international conferences and exhibits; and organization and dissemination of technical information. In addition, education and job training will be provided to regulatory personnel of the States, to permit early assumption by the States of regulatory and inspection functions with respect to byproduct, source, and special nuclear materials. The provision of this job training is authorized by Public Law 86-373.

CIVILIAN APPLICATIONS OF ISOTOPES AND NUCLEAR EXPLOSIVES

Successful applications of radioisotopes and high-intensity radiation sources, as well as civilian applications of nuclear explosives, carried under the code word "Plowshare," promise to be of major economic significance and public benefit.

While the basic principles of radioisotopes use have been known for about 25 years and we have made important progress in certain areas of use, such as gaging and radiography, broad application is relatively unexploited. Our atomic energy activities of the last few years have made available a large number and variety of isotopes with a wide range of properties. Judicious participation by the Government in supporting research and development where gaps exist in radioisotope and radiation technology, as well as in increasing training opportunities, will accelerate realization of the benefits from this important area of technology.

An interesting application presently under study is that of food preservation. The Army has a program underway which is aimed at determining the military usefulness of high-dose food irradiation. Since low-dose processing is believed to have greater potential commercial benefit, the AEC efforts will be oriented in this direction.

These two programs will complement each other and will constitute the basic elements of an aggressive national program.

In the Plowshare program several possible peaceful uses of nuclear explosives are being investigated. These include large-scale earth movement, recovery of oil from shale and tar sands, production of isotopes, and generation of power.

A series of high-explosive shots in various media to determine the relationship of crater dimensions to depth of burial, effects of simultaneously detonated charges, and empirical verification of theoretical scaling laws will be conducted.

Bioenvironmental studies related to the proposed Cape Thompson experiment, Project Chariot, will continue.

Construction and site preparation for the Gnome experiment in New Mexico will also continue, and subject to Presidential approval, the nuclear detonation is programed for the spring of 1961. This experiment is designed to provide information on generating power and recovering isotopes from a contained nuclear explosion, and in addition, it is planned to utilize the high-neutron flux from the detonation to make neutron cross section measurements which will contribute to scientific knowledge and to the reactor development program.

COMMUNITY

This year, for the first time, the portion of the program estimate covering operation of the communities of Oak Ridge, Tenn., and Richland, Wash., consists almost entirely of assistance payments to these newly incorporated communities, as provided for in chapter 9 of the Atomic Energy Community Act of 1955. The transfer of municipal installations to eligible local entities will have been completed by the beginning of the fiscal year. Most of the real estate has already been sold.

The community of Los Alamos, N. Mex., continues to be operated under Government ownership.

PROGRAM DIRECTION AND ADMINISTRATION

Our final major category is program direction and administration, which includes salary and other costs of AEC personnel engaged in the overall formulation, planning, and supervision of Commission activities. Costs of about 4,900 employees are included in this category, as compared with about 2,000 AEC employees engaged in such direct program activity as operation of weapon storage sites. Most of the 4,900 employees are located in 12 operations offices and their subordinate area and branch offices in various parts of the United States. These employees administer production, research and development, construction, and related activities performed by contractors having a total work force of more than 110,000 persons. In addition to contract administration, activities of these AEC employees include developing civilian uses of atomic energy; licensing, regulating, and inspecting peaceful uses of atomic energy; developing standards and control measures for internal security and for protection of Government funds and property, and conducting the program of cooperation with other nations.

An increase of 100 employees is contemplated, almost entirely for the AEC's reactor development program. With the increasing scope and complexity of reactor development activity, additional scientific and engineering staff is needed at the field offices to follow closely, at the technical level, the operation and construction of reactor projects. At headquarters additional technical people are required to keep fully current with the rapidly growing technology, and to evaluate new knowledge, so that we can recognize those truly significant developments which warrant vigorous effort and generous support, and contrariwise, developments which suggest curtailment or even abandonment of particular investigations or projects.

This concludes my statement, Mr. Chairman. The other Commissioners and I would be pleased to answer any questions members of the committee may have. The General Manager and the staff are prepared, of course, to take up the budget estimates in greater detail.

Thank you.

PROGRESS IN ADAPTING ATOMIC ENERGY TO INDUSTRIAL USES

Mr. CANNON. Mr. Chairman, the subject with which we deal here is the most important both in national defense and in our economic and industrial economy of any before the committee or the Congress today. It has greater possibilities, greater potentialities, and the situation is urgent and requires as prompt action as possible.

I must confess that although you and your predecessors have warned us for the last 2 or 3 years that progress will be slow, we drew the conclusion that you were a little too pessimistic, and that in a very short time atomic energy would be available in both fields in the near future.

We have discovered, however, your forecast was correct. Progress has been much slower than we anticipated, and especially in the adaptation of atomic energy to industry. I think perhaps we were thrown a little off balance by the fact that England had made such tremendous strides in the adaptation of atomic energy to the development of industry and has been for some time feeding into her conventional electric power systems, the product of her great plants over there.

What is your expectation now, after another year of development and experiment, as to the probable time in which we will be able to use atomic energy effectively in national defense and in industry generally? Do you still foresee a long wait, or do you think that the goal is materially nearer at this time?

Mr. MCCONE. I think, Mr. Chairman, that developments of the last year, since I last appeared before this committee, have been encouraging. I would like to take this opportunity to report to you, because I feel that we are closer to the time when atomic energy will be used on an economic basis, by industry, than appeared to be the case a year ago, closer by more than the intervening year. I think it is quite significant that two of our major industries, the General Electric Co., who have concentrated their development on the boiling water-type reactor, and the Westinghouse Co., who has concentrated their development on the pressurized water reactor, have been able to quote to industry on a fixed-price basis plants in the order of 300,000 kilo-

watts and their prices have been such that when they were appraised by the utilities and proper account was taken of the cost of the fuel cycle and the operation and so forth, the resultant power began to look reasonably competitive with power from conventional sources in modern plants of similar sizes in areas where fuel is relatively high priced.

The most significant situation is in the State of California where the utilities are forced to bring in gas or fuel oil from distant points and at costs which lead them to the conclusion that nuclear plants in their present state of development would be reasonably competitive over the life of the plant. This is an encouraging development.

Mr. CANNON. Competitive with conventional supplies of power and energy?

Mr. MCCONE. That is right.

There are two companies in California that are now in active negotiation for such plants and while no contracts have been firmed up, no final decisions have been made by management or directors, it has been reported to me that negotiations are most favorable and both the power companies and engineering firms that are working with them feel quite optimistic that decisions will be made to build plants of this size.

You made a comment on the situation in Great Britain. I have followed that very closely. Great Britain has a unique situation. Fuel is expensive, much higher in cost than our fuel, and furthermore, because of the inadequacy of their supply, they must import a considerable amount of fuel in the form of fuel oil, and this has the added disadvantage to them of a drain on their balance of payments. For this reason, nuclear power has been very attractive to them. The plants that they have built have been successful. They have been good. There is no place in the United States where they would have been of any value to us at all.

Mr. CANNON. The English have recently built, or they have in process of construction, plants in the north of Scotland and elsewhere. Have they in these newer plants made improvements on the method and process used at Calder Hall?

Mr. MCCONE. They are building several generations of the Calder Hall type of reactor which is a natural uranium gas-cooled reactor. This is the principal type of reactor in their present program. They are in addition developing what they term "an advanced gas-cooled reactor," which will be higher temperature, and will be fueled with slightly enriched uranium contrasted with natural uranium. They feel that their next generation plants will be of this type and that the plant cost will be less than the Calder Hall type, and the resultant power will be somewhat larger. They are, together with the OEEC countries, experimenting on a still further advancement which they refer to as the high-temperature gas-cooled reactor. This they feel is somewhat further removed but they think it will be the following generation plant.

In northern Scotland they have completed and started initial operation at Dounreay of a fast reactor. This I think they look upon as still further removed.

Now, as you know, we are paralleling these developments in both the advanced gas-cooled reactor where we are building such a plant at

Oak Ridge under authorizations of last year, the high temperature gas-cooled reactor, which we are supporting with research and development with a group of utilities building the plant headed by the Philadelphia Electric Co., and that plant has gone forward. Also, we have three fast reactor undertakings, two fast reactor experiments, one in operation at Idaho, and one under construction to go into operation in early 1961 at Idaho, and the Fermi plant, which is nearing completion in the vicinity of Detroit.

So we have very close cooperation with the British in all of these new fields and all of them will be improvements in one form or another over the so-called Calder Hall type of reactor.

Mr. CANNON. How do these plants compare with the plant at Shippingport?

Mr. MCCONE. The Shippingport plant is a pressurized water reactor. I don't think the plants are comparable. The Shippingport plant has proven a very valuable asset in our development program, because we have been able to demonstrate the possibilities of the use of fuel elements in a way that otherwise would not have been possible.

I think that the fact that the second core at Shippingport will have a capacity of about 150 megawatts gross electrical as contrasted with 67 megawatts of the first core is a very significant advance in this particular process.

DELAY IN ACHIEVING ELECTRICITY

Mr. CANNON. I note in the U.S. News & World Report on March 7, the statement that—

> Atomic power has run into a long delay.

The articles goes on to say—

> They don't expect cheap electricity from the atom for a long time, so say the power authorities.

It continues—

> A look at the problems shared abroad shows that the bright dream of getting cheap electric power from the atom has all but collapsed.

That is a very pessimistic view of it—

> It is being discovered in the United States and all around the world that years of slow costly trials lie ahead before the atomic power becomes practical on a wide scale. The early atomic power plants being built today are extremely expensive producers of electricity and in the opinion of many experts will need to be changed repeatedly as due process for exploiting nuclear reactions are developed.

That about sums up your judgment of the situation, does it, Mr. Chairman?

Mr. MCCONE. No; I am not quite as pessimistic as that article. I realize that the technical problems and the problems of developing nuclear plants at reasonable capital cost have been more severe than was expected.

I have just returned from France where I inspected all of the plants that are under construction or projected there. I was at their various plants last week. They have a substantial program totaling eight or nine hundred thousand kilowatts electrical in four different types of plants, and while they recognize that the problems are great,

they nevertheless are approaching the problems with considerable courage and, I might say, optimistically.

I will conclude, Mr. Chairman, by saying that I think the two plants that are under discussion in California—and I hope that the negotiations will be successful, although, as I have said, they have not been consummated—somewhat disputes that statement in the magazine you quoted from.

I do recognize, however, when we get into low cost fuel areas where coal and oil or gas are near at hand, it will be a long time before nuclear power is competitive.

Mr. CANNON. You do concede that the first statement, the heading, "Atomic Power Runs Into Long Delay," is fairly accurate?

Mr. MCCONE. I would say that is right.

Mr. CANNON. I notice in the New York Herald Tribune a statement to the effect that:

A power company official predicted yesterday that atomic energy will be the predominant source of electrical energy for the year 2000, but will be filling only 20 percent of the Nation's fuel needs at that time.

Now, the year 2000 is still several years away and 20 percent of our fuel needs will not be quite so decisive as we had expected the first nuclear power from these plants to be.

Here is another more optimistic view. The Journal of Commerce tells us:

The chairman of Westinghouse Electric Corp. says that design of some large nuclear powerplants have reached the point where they are now competitive with conventional generating facilities in the high cost fuel areas.

That does not quite seem to agree with your views. That includes high cost fuel areas in the United States?

Mr. MCCONE. And elsewhere in the world. I think that that statement attributed to a Westinghouse executive referred to the United States, and I think he was thinking particularly of a location such as California.

Mr. CANNON. The New York Herald Tribune says:

The Nation's first privately financed nuclear power station being built 50 miles southwest of Chicago will produce, General Electric forecasts, competitive "A" power by 1966.

That has a more hopeful point of view. 1966 instead of 2000. He does not say what proportion of the national need will be supplied at that time as compared with the first statement that 20 percent will be supplied.

Here is another statement:

Britain says that United States runs a poor third in the "A" power race.

Of course, I hardly think England would be prejudiced in making such a statement. They are willing to make a statement that, United States runs a poor third in "A" power race when at the beginning we started with a lead and should have maintained that lead.

Mr. MCCONE. If I may comment on that——

Mr. CANNON. If you will permit, the article explains the basis of their statement:

The United Kingdom Energy Authority report which was made before the Parliament today said that four British stations under construction would have a total output of 1,400 megawatts.

They give the second place to Russia:

The Russian output will also be 1,400 megawatts from three large power stations now going up and from another now in operation in Siberia at the present time.

I quote these to indicate that there seems to be a wide difference of opinion upon the part of the press of the country and, of course, these modern reporters who have been carefully selected and carefully trained and who are energetic and enterprising and usually go as far as possible in securing dependable data, seem to disagree because here is a quotation from the New York Times to the effect that:

The atom during the 1960's should at least start fulfilling its promises as a volatile new source of energy for mankind after years of frustrating technical difficulties and delays.

I don't know whether that delay points to a lag in the general scientific development of academic science in the country or whether it points to delays on the part of this committee or possibly on the part of the Commission, but it seems to take for granted that everybody will concede that there have been frustrating and technical difficulties. "Nuclear power is now being viewed in Government and industry as being just around the corner." I would much rather take the Times point of view but I am disappointed to note that Chairman McCone seems to agree with the less optimistic point of view.

VALIDITY OF RUSSIAN COMMITMENTS

Of course, the matter of most immediate concern, Mr. Chairman, is the proposed and apparently operating restrictions on experiments. It is our understanding that as a result of the Geneva discussion there is a joint program between the AEC and the Department of Defense for the investigation of seismic effect of underground atomic explosions.

I would like to say parenthetically, that I have not the slightest confidence in any agreement Russia makes. A very careful study shows that Russia has never kept any treaty ever made, never kept any international promise ever entered into and in a vital matter like this, so far as I am concerned, it is absurd for us to expect them to keep any agreement they later find it to their interest to disregard. There is always the possibility they are merely leading us into a trap in which we have found ourselves too frequently in the past.

I cannot say that is to be attributed to Russia only. I remember many years ago attending a session of the Four Power Conference which met down here at Continental Memorial Hall. It was attended by the United States, Britain, France, and I believe the fourth power was Italy. They entered into a solemn agreement, signed with great ceremony, that each of them reduce their naval force by a common percentage. The United States sank several effective battleships and the rest of them sank blueprints. Russia has never kept its agreements. It is absurd, under the circumstances, for us to interfere in the slightest with the development of our study of this most vital subject. If we lose here we lose for all time to come. There is no second chance. And we are dealing not with the matter of winning a war. We are dealing with survival. So, so far as I am concerned,

I sincerely trust we will never really depend in any vital matter on any promise Russia makes.

Apparently from your statement made here, you are complying with directions from some authoritative source to restrict your investigations, and apparently it is done at the expense of progress. Apparently you are doing it reluctantly, if I am reading between the lines. You probably are not in a position to speak or would not care to speak on that subject with any particular emphasis at this time, but I will say it is my opinion, and so far as I have heard it expressed, the opinion of most other members of this committee, that there is too much at stake to take even a slight risk.

The stakes for which we are playing are too great. It means not only survival of the United States and our form of government, but it means survival of Christian civilization, and I am not in sympathy with any restriction whatever upon the Atomic Energy Commission in this respect.

STUDIES FOR SEISMIC IMPROVEMENT

Now I would like to ask you—we have understood that there is some likelihood of a supplemental budget being submitted to the Congress. As far as this joint program between the AEC and the Department of Defense is concerned, how much money is in the budget to support the AEC portion of these studies?

Mr. McCone. You are referring to the studies for seismic improvement?

Mr. Cannon. The result of the Geneva discussion.

Mr. McCone. There is no money in there. There is some amount of money being spent in fiscal year 1960—a small amount of money for developing instrumentation for the high altitude detection system, but there is no money in the budget for the seismic improvement program which is under discussion. If that seismic improvement program is undertaken, then funds for the work will have to be provided either from other sources, such as the Department of Defense reserve fund or by some form of supplemental appropriation.

WEAPON IMPROVEMENT BY UNDERGROUND TESTING

Mr. Cannon. Do you think, Mr. Chairman, that significant improvement in weapon construction can be made underground?

Mr. McCone. It is my personal opinion that experimentation and research work will develop some significant improvement in seismic detection. I likewise feel that we will probably witness developments of methods to deceive a detection system. As a consequence, we may not improve the relative position very much.

Mr. Cannon. Could other countries make significant advances in weapon design if they conducted underground tests and we failed to do so?

Mr. McCone. There is no question about the fact that weapon improvement can be made by underground testing. Improvements can be made by this country if we proceed with underground testing. If another country were to proceed with underground testing, they would make significant improvements in weapons. The improvements would

be second only in my opinion to the advances that were made when we stepped from the A bomb to the H bomb.

Mr. CANNON. The press in the last few weeks indicates that it is possible for some tests to be conducted underground without detection.

Mr. MCCONE. That is correct.

Mr. CANNON. And that there would be no practical method of policing any agreement not to adopt underground methods.

Mr. MCCONE. That is true with known technology; yes, sir.

GENEVA AGREEMENTS

Mr. CANNON. Now, all of this seems to be—you do not mention it in your statement, you merely mention that you are following directions—the result of the agreements reached at Geneva. Will you tell us specifically what the Prime Minister of England and what the President agreed to at Geneva affecting this situation?

Mr. MCCONE. Yes. In the first place, as I reported to you a year ago, an effort is being made to reach an agreement for the suspension of nuclear tests to the extent such a suspension could be properly safeguarded by the establishment of a control system. It was determined that the control system as originally conceived had some limitations with respect to its capability so that it could not adequately safeguard explosions below something of the order of 20 kilotons. It was felt that if the detection system was installed, a country such as Russia, if they chose to proceed in a clandestine manner, could carry out explosions less than 20 kilotons without detection. For this reason the President proposed on February 11 that we establish a threshold and that the suspension apply to all tests above the threshold. This would involve all tests in the sensible atmosphere, that is above ground, and under water for those are readily detectable by means external to the country, and tests above a threshold of a 4.75 indication on a seismograph which refers to a so-called Richter scale. It was felt that with a reasonable number of onsite inspections, we could be assured that the Soviets were not carrying out tests of greater magnitude than about 20 kilotons which show a 4.75-scale record on the seismograph that would be established under the agreed Geneva system.

Now, the President and Prime Minister McMillan proposed that if such agreement was reached and progress was made toward installing this protection system, they would unilaterally declare a moratorium on tests below this threshold for a period of time, the length of time being undisclosed, while we carried on a research program which was designed to improve the detection system and thereby lower the threshold or possibly provide for the detection of all underground explosions. This was made by agreement between them in the hope of making progress in this area of test suspension as an initial step in this very important field of disarmament, recognizing that there was some risk connected with it. It was recognized as possible that the Soviets might or could, if they so chose, cheat on the agreement and carry out tests in a clandestine manner. By doing so they would make some weapon advances that we would not make.

This, in general, is the substance of the decision that was reached by the President and the Prime Minister, which was reported rather fully in the press.

Mr. CANNON. It is in effect a unilateral agreement. Russia did not participate.

Mr. MCCONE. No, Russia would make a similar declaration that they would abstain from tests during the agreed period. The point is that being a closed country, there would be no way for us to be sure that they were complying. To that extent we would be dealing for the period involved on a matter of faith.

Mr. CANNON. Off the record.

(Discussion off the record.)

RELATIONSHIP WITH NATIONAL SPACE AGENCY

Mr. CANNON. Passing on to another subject, I would like to ask what is your relationship with the National Space Agency and how your program is coordinated with theirs in respect to nuclear propulsion and auxiliary power units for space flight.

Mr. MCCONE. Up until very recently we had a broad relationship with the entire space agency program because by law the chairman of the Atomic Energy Commission was one of the members of the National Space Council. Under a revision of the law which is now being considered by the Congress, the Space Council will be eliminated. It was considered by the President to have served its purpose, and the space agency will operate under an executive director.

In programs in which we have a common interest, such as the ROVER and SNAP programs, the administration of the program is by collaboration between the AEC program director and the program directors of the Space Agency. In the case of ROVER, by far the largest part of the current program is handled by AEC although there are some important parts of the program that are funded and handled by the Space Agency. Those include such things as the pumps for the liquid hydrogen and other components.

Now, this at the present time is being handled by close collaborative arrangements. We are giving consideration to, but have not finally developed, a plan somewhat similar to the plan we have with the Navy on naval reactors where one man, in the instance of the naval reactors, Admiral Rickover, serves as representative and spokesman of both the Navy and the AEC. We would envisage that a man would serve as a representative and spokesman of both the National Space Agency and the AEC on the undertakings in which we have a common interest.

Mr. CANNON. Off the record.

(Discussion off the record.)

Mr. CANNON. I have an analysis here prepared by the staff of the committee. I would like to read certain portions of it and get your reaction.

The National Aeronautics and Space Act of 1958 in its declaration of policy and purpose—that is section (*c*) of paragraph A—calls for "the most effective utilization of the scientific and engineering resources of the United States with close cooperation among all interested agencies of the United States in order to avoid unnecessary duplication of effort, facilities, and equipment."

I would like to repeat that—"unnecessary duplication of effort, facilities, and equipment."

This section was incorporated in the law after extensive testimony in committee to the effect that the Space Agency would be required to use existing Government facilities since it would be wasteful to create a whole new complex of developmental work.

Would you agree to that statement, Mr. Chairman?

Mr. McCone. Yes, I agree that there must be the closest cooperation between the Space Agency and other agencies active in related fields and every attempt is made to accomplish that as far as the Atomic Energy Commission is concerned with the Space Agency. A more difficult problem is to accomplish the purpose of that paragraph you read in the relationship between the Department of Defense and the Space Agency, because there are much broader fields of common interests.

Mr. Cannon. And for the purpose of avoiding unnecessary duplication of effort especially in equipment.

Mr. McCone. That has to be accomplished; otherwise there would be great waste.

Mr. Cannon. Again, under the Atomic Energy Act of 1954, agencies of Government other than the Department of Defense are looked upon as licensees of the Commission in nuclear activities. However, the broad field of nuclear research, regardless of application, is the domain of the Atomic Energy Commission among the agencies of Government. Section 31 of the Atomic Energy Act of 1954 directs—it is mandatory—directs the Atomic Energy Commission to exercise its powers in all the broad fields of nuclear research. The wording of the section can leave little doubt that other agencies of Government cannot carry forward areas of nuclear research, unless the Atomic Energy Commission initiates this action.

Section 31 authorizes and directs the Atomic Energy Commission to make arrangements (including contracts, agreements, and loans) for the conduct of research and development. In the course of carrying this forward, the Atomic Energy Commission could initiate an action under which other agencies of Government would carry forward research and development for them. However, the work would be under the direction of the Atomic Energy Commission, and they would retain the initiative and control. No interpretation of section 31 would place initiative and direction of atomic research and development in another agency.

Would you agree to that statement?

Mr. McCone. Yes; I think that is correct.

Mr. Cannon. Again, laws would have to be strained and the intent of Congress perverted to reach a conclusion that the National Aeronautics and Space Administration was free to duplicate nuclear research. No provision of the Space Act contradicts section 31 of the Atomic Energy Act.

What about that statement?

Mr. McCone. I think that is correct, as I understand it.

Mr. Cannon. And, again, the NASA program justification data under the general category "Program and performance, section 2, paragraph (f)" reads as follows:

> Space propulsion technology: This self-activtity fund, the development of advanced propulsion techniques and systems for application to future space vehicles. Work will be continued in 1961 on the single-chambered 1.5-million-pound-thrust engine. Advanced liquid and solid fuel rocket engines

—and this especially—

nuclear rocket and electrical propulsion systems and nuclear solar and electrical auxiliary power supplies for payload applications.

What does that imply, Mr. Chairman?

Mr. McCone. That implies a responsibility to develop systems. This does not imply that they are developing the reactors or, in the case of the SNAP devices, the device itself. They are developing the systems in which these devices will be used after the basic research has been performed by the Atomic Energy Commission and the unit brought to a point where it can be worked into a system.

Mr. Cannon. Once more—before the National Aeronautics and Space Act of 1958, the National Advisory Committee on Aeronautics apparently sought to assist the Atomic Energy Commission and provided for the construction of a nuclear reactor at Plumbrook, Ohio, for manned aircraft nuclear research. Today this testing reactor is an atomic energy research and development tool available to the NASA, Lewis Center. NASA now seems to be entering the nuclear field contrary to law and proposes utilizing 145 employees at Plumbrook at $1.3 million for purposes which are not delineated.

Now, what will those 145 employees be doing, Mr. Chairman?

Mr. McCone. As I understand the purpose of the reactor, it was that NACA, before NASA came into existence, felt, and it was agreed, that their responsibility would be to examine the effects of radiation on the component part of the aircraft. The AEC was developing the nuclear propulsion for an aircraft, but NACA, as I understand it, assumed the responsibility for examining the effects of radiation on the component parts of the aircraft, and this reactor was built with that in mind.

I understand that this organization was set up by, first, NACA, and now is carried on by NASA for that purpose.

Mr. Cannon. Mr. Chairman, does AEC have facilities for investigating the effects of radiation on such devices?

Mr. McCone. Yes; in a variety of ways. Whether we have the duplicate facilities of NASA, I could not say.

Mr. Cannon. That is not duplication, then?

Mr. McCone. No; I do not think it is a duplication. It is an area that I intend to examine very carefully personally to see that there is no duplication and to see that the initial purpose was sound. There is a similar problem arising with or or two other agencies of Government. You may have read a few months ago that the Bureau of Standards, in their new laboratories which they are going to build in Maryland, plan a reactor. I intend to examine to see that this does not involve the type of research which by law is assigned to AEC. It may be, however, that the Bureau of Standards, in accomplishing their mission and their legal obligation, must have some source of radiation for which they will need a reactor.

Mr. Cannon. I trust that the matter will be fully explored before any definite action is taken.

Mr. McCone. That is correct, sir.

Mr. Cannon. Really, Mr. Chairman, how did this research get into the hands of NASA?

Mr. McCone. I cannot answer that fully, sir.

Mr. CANNON. Obviously, I should think it would be the responsibility of AEC.

Mr. MCCONE. Perhaps the General Manager, who has been following this rather intimately, could answer that.

Mr. CANNON. Yes. We will be glad to hear from him.

General LUEDECKE. I wish to go back to the chairman's statement that when the project was conceived under NACA, before NASA was formed, its purpose, as agreed by the Commission at that time, was to perform the radiation services and the radiation environmental work on components related to the aircraft nuclear propulsion program.

During the time that the reactor has been under design development and construction, other facilities have become available and NASA has been formed, nuclear rockets have come to the fore, and NASA is now directly interested in those civilian aspects of rocketry, primarily ROVER.

While I understand that the Plumbrook facility is not yet in operation, it is located adjacent to their Lewis Laboratory, and it would be their intent to utilize the facility to determine the environmental effects on the remainder of the propulsion system, aside from the reactor and not that part of the system which is the developmental responsibility of the Commission.

It is difficult to bring the two areas together in such manner that the people charged with the development of the system will have enough information, knowledge, and competence to integrate a nuclear reactor into a vehicle and be prepared to accept responsibility for the operation of the vehicle. It is my understanding that NASA intends the Plumbrook reactor, when it comes into operation, to fulfill this purpose.

Mr. CANNON. Well, Mr. Luedecke, who is going to check on the reactor and who will check on the airplane?

General LUEDECKE. By check, you mean determine what it is used for?

Mr. CANNON. Certainly. Who is going to check on the reactor and who will check on the airplane so far as radiation is concerned?

General LUEDECKE. The reactor will be in the category of a licensed facility, and it will have to meet safety standards for operation.

Mr. CANNON. You do not think that that is intrusion in the field of AEC?

The original purpose of this facility was to check on the aircraft. Don't you think they are going just a little bit afield?

General LUEDECKE. It is going beyond use for the aircraft nuclear propulsion program for which it was conceived, sir. The present program is somewhat broader and other systems will require the same kind of work.

Mr. CANNON. Who will do the checking on the aircraft?

General LUEDECKE. The entire aircraft and the entire propulsion system are under the Air Force and AEC, which is managed by a joint group in AEC, so the nuclear reactor will be the job of the Atomic Energy Commission.

Mr. CANNON. It is difficult to see how this tends in any direction but taking over of certain functions of the AEC. Now, specifically the following items in the NASA budget raise questions of duplication. For example, nuclear reactor division, Lewis Research Center

in the budget for $1,206,564. What would you say of that item, Mr. Chairman?

Mr. McCone. I am not familiar with their organization at all, Mr. Chairman, so I can't comment on it.

Mr. Cannon. I think that should be gone into very carefully before we report a bill.

Here is another item. Plumbrook research facility, $670,594. What about that item?

Mr. McCone. That is in the same category. That is the Plumbrook reactor is a tool of the Lewis Laboratory organization, I would assume.

Mr. Cannon. What about the energy conversion laboratory, for which $5,050,000 is asked?

Mr. McCone. I am not acquainted with that.

Mr. Cannon. Among the research and development programs, there is listed a research and development program in nuclear systems technology. The program justifications data run from page 177 to page 183 consistently referring to nuclear development, to cost $10 million. What would you say of that?

Mr. McCone. It is in the NASA budget? We have in our budget a very substantial amount of money for the development of the Rover project and certain SNAP devices. We intend to carry this Rover project on to a point where it is proven out so that it can be used by NASA for flight. The development of the systems for the use of this reactor is up to NASA, and the same is true of certain SNAP devices.

Mr. Cannon. This $10 million will be spent for work which you are supposed to direct?

Mr. McCone. No; we have no responsibility for developing the systems on which this reactor or SNAP device is to be used. We develop the devices in our laboratory, but their application to flight or to space work is up to NASA or to the appropriate agencies in the Department of Defense.

Mr. Pillion. Will the gentleman yield?

The Chairman. The gentleman from New York.

Mr. Pillion. Mr. Chairman, how can the committe be assured that these items mentioned by the chairman will not result in duplication or waste? Who in the two areas, yours and NASA's, will determine whether or not there are duplications that we are not building up another parallel, duplicating, wasteful area of research? How is that to be determined and how will this committee be assured that we are not running into a situation where we are wasting money, brain, and manpower in duplication? I think that is what the chairman is getting at.

Mr. McCone. Yes; and I think it is a provocative question. I think it can be answered in two ways. I think first the coordinate arrangements between the two departments, NASA and the AEC, has as their purpose among other things to avoid such duplication. Secondly, the budgets of both departments are very carefully examined by the Bureau of the Budget in their review process and one of the matters that they direct a great deal of attention to in their review is areas of duplication of this type.

Now, we in AEC do not review the NASA budget nor does NASA review our budget.

Mr. CANNON. Supplementing what the gentleman from New York, Mr. Pillion, has said, we have here in the NASA budget the provision for this $10 million I have mentioned.

It is one of the purposes of the present program to do the research necessary to develop high power, light weight nuclear reactor electric generator systems. It is felt that the development of such high power systems must wait for the accumulation of various fundamental data and research on critical components of the system. In addition to the fund required for applied research leading to advanced high power systems, funds are included in this program to continue the development of a system for converting energy from nuclear heat to electrical power using currently available information. This conversion system will be matched with the SNAP reactor being developed at the request of NASA by the Atomic Energy Commission. This reactor electric system will produce enough power to supply communication needs for planetary missions as well as to test earlier versions of the electrical propulsion system.

They seem to be taking over SNAP.

Mr. MCCONE. No; I think the central word there is "systems" as contrasted with the devices. Now, the system involves not only the SNAP device, but the rotating equipment, and a great deal that goes with it. I would imagine that that is the manner in which they are directing their effort. I do not feel that this plan involves the taking over or the duplicating of the area of research and development carried on by the AEC.

Mr. CANNON. You do not think the expenditure of money for this purpose would be in any way a duplication of money you are spending for any similar purpose?

Mr. MCCONE. Not so far as I know; no, sir.

The CHAIRMAN. The committee will stand adjourned until 2 o'clock.

AFTERNOON SESSION

The CHAIRMAN. The committee will be in order.

Mr. Pillion.

Mr. PILLION. Thank you, Mr. Chairman.

SUPPLEMENTAL BUDGET ESTIMATE

I note, Mr. Chairman, that the overall estimate for this year is $2,464,300,000, a reduction somewhat from the 1960 estimate. Do you anticipate any supplemental request to that, Mr. Chairman?

Mr. MCCONE. No, I think not, Mr. Pillion, except under a circumstance in which a new activity might be created that was not provided for. As explained to the chairman, there is no provision in this estimate for the carrying on of the seismic detection improvement program.

Mr. PILLION. I am sure other members of the committee are equally pleased to see a slight reduction in the request for 1961.

Mr. MCCONE. Yes, our budget was very carefully reviewed by the Commission. It is a tight budget.

RAW MATERIALS

Mr. PILLION. I note that the Commission is committed to the purchase of raw materials up to December 31, 1966. In the event of a total disarmament, we would still be committed to purchasing these raw materials? I believe this to be an outside prospect, but how does

that mesh in with the proposed summit meeting and perhaps the idea of total disarmament?

Mr. McCone. These are firm contractual commitments, and they would have to be resolved either by accepting delivery and using such portions of the uranium oxide as we could for our power program and other peaceful uses or negotiating some equitable liquidation of some of these contracts.

There is, however, a commitment for about $3 billion, and this is a firm commitment.

Mr. Pillion. Are there any commitments beyond December 31, 1966?

Mr. McCone. None—I would like to qualify that. There may be one or two that run a few months.

Mr. Pillion. Nothing substantial?

Mr. McCone. That is correct.

Mr. Pillion. You might think of adding an escape clause of that type maybe in your next contracts.

Mr. McCone. Well, new contracts would be different from the old ones because they would be with producers who had built and presumably amortized their plants, and therefore it would not be necessary to make such irrevocable long-range commitments that were necessary originally. As you know, the contracts were used by the operators for financing purposes, and therefore they had to be firm.

POWER REACTORS FOR ANTARCTIC

Mr. Pillion. My next notation on the pad is the antarctic. Are you now working on reactors for the antarctic?

Mr. McCone. We have reactors designed and developed and can produce them which will be useful in the antarctic. We feel this is a very reasonable use for small portable reactors. However, the responsibility for installing and for budgeting for installation in the antarctic is the responsibility of the Navy. We are hopeful that they will be able to find a way to budget for such a reactor.

Mr. Pillion. You do have reactors for Greenland?

Mr. McCone. No; AEC has not budgeted any reactors for Greenland. However, the Army is putting one in Greenland, on the icecap, but not at Thule.

Mr. Pillion. I was at the antarctic last fall. I realize that they could be used very effectively, probably at McMurdo. I am wondering about the political repercussion if we were to install a reactor there, one or more, with the Soviet enlarging its operation in the antarctic, whether or not there would be a reaction to the point where they would say, "Well, we can install nuclear reactors and perhaps nuclear weapons," based on the idea that we have installed nuclear reactors, say, for a purpose other than a weapon. I am a little bit fearful that the Navy is seriously thinking of installing reactors in McMurdo and the notion around the world would be that we are using the antarctic for nuclear testing, perhaps, or nuclear weapon testing, that idea would be spread around the world. What is your comment about that, Mr. Chairman?

Mr. McCone. I don't think that would be the interpretation.

Mr. Taber. That ought to be off the record, should it not?

The CHAIRMAN. Off the record. Proceed.
(Discussion off the record.)

REACTOR FUNCTIONS

Mr. PILLION. Now, Mr. Chairman, how do you classify your reactors? Do you classify them by functions? Some have a function to produce power, others heat, others to produce radiation. Do you have a classification by function of reactors?

Mr. MCCONE. Yes. Most of the reactors are for production of power. There is a second function, that of producing heat. If you will recall, last year there was authorized a demonstration process heat reactor which will be built in conjunction with the Department of the Interior as a saline water purification plant. A third function of a reactor is for the production of isotopes or for medical purposes such as the reactor at Brookhaven, which has only recently been put into operation. Of course, underlying all of this are the test reactors and the reactor experiments which are to demonstrate the several processes there involved.

REACTOR MANUFACTURING

Mr. PILLION. And does your Commission manufacture reactors or are some of the reactors manufactured by commercial firms?

Mr. MCCONE. The Commission does not manufacture any reactors. We make the arrangements so that they will be manufactured by commercial firms. In other instances, private industry itself provides for the construction of the reactor, including all financial aspects of it. Our function is merely that of licensing the reactor and looking after the public health and safety.

Mr. PILLION. There is no reactor manufactured whatever by the Commission itself?

Mr. MCCONE. No.

PROGRESS BY OTHER NATIONS

Mr. PILLION. What is your estimate of the progress of Red China in the field of atomic energy, Mr. Chairman?

Mr. MCCONE. I have no estimate, Mr. Pillion. We have some information, that is more gossip than anything else, that Red China has a program. When I was in the Soviet Union, the director of the Dubna Laboratory had just returned from Red China, and from what he said, it was obvious that they do have a program. Just how far it has advanced, I do not know.

Mr. PILLION. We have no firm information on it?

Mr. MCCONE. None. We know that they have some laboratories and some experimental apparatus. I feel that they must be working both in the field of nuclear power and weapons, too.

Mr. PILLION. The situation with France, Mr. Chairman, you anticipate that she will become a major nuclear power in the period of the next 5 to 10 years?

Mr. MCCONE. I just returned from France. The fact is I was over there last week, and I examined their program very carefully. There were several of the Atomic Energy Commission organization with

me, including Dr. Warren Johnson, Chairman of our Advisory Committee.

(Discussion off the record.)

REACTOR SELECTION PROCESS

Mr. CANNON. Supplementing what the gentleman from New York has said, early planes were mostly kites. The biplane was little more than a kite with motor attached. The earliest automobiles were buggies with motor attached, and in both instances the development was through private industry. Now, unfortunately, here it is too costly, too expensive, and any return on the investment would be too problematical and too long delayed for us to leave to industry to develop unaided the most practical reactor, as it did the most practical airplane, the most practical automobile. But you do expect, as I understood you tell Mr. Pillion, to make the selection of the most practical reactor for industrial purposes in about how long?

Mr. MCCONE. We are going through that process of selection continuously. I do not think that we are at a point that we can say there is one that is the most practical and eliminate all others.

Mr. CANNON. You are reaching that stage?

Mr. MCCONE. No; I don't think so. I don't think there will ever be a time when we will settle on a single reactor concept for the reason that this is too new and too evolutionary a business at this time. I do not think that we could expect to make a determination that a pressurized water reactor or an organic moderator reactor offers the final answer. We must keep exploring several approaches.

Mr. CANNON. But you do expect to screen out many now under consideration?

Mr. MCCONE. That is correct.

Mr. CANNON. At this point we will insert in the record the remarks by Mr. Pittman, Director of the Division of Reactor Development, on November 3, 1959, before the Atomic Industrial Forum, discussing this phase of the situation.

(The information referred to follows:)

REMARKS BY FRANK K. PITTMAN, DIRECTOR, DIVISION OF REACTOR DEVELOPMENT, U.S. ATOMIC ENERY COMMISSION, FOR PRESENTATION AT THE 1959 ANNUAL CONFERENCE OF THE ATOMIC INDUSTRIAL FORUM, WASHINGTON, D.C., NOVEMBER 3, 1959

POWER REACTOR POTENTIALS

Ladies and gentlemen, it gives me great pleasure to be able to talk to you today on the subject of power reactor protentials. The Commission's civilian nuclear power program may be said to date officially from the passage of the 1954 amendment to the Atomic Energy Act. During the first 5 years of this program, much has been accomplished. Major research and development programs have been carried out by the Government and by industry, with the result that sufficient information has been generated on eight separate reactor systems to indicate that it is technically feasible to use them for the generation of electric power. For some of these concepts, there have been, or are now being, constructed power-producing prototypes which will gather the operating experience and economic data needed to show the way to economic nuclear power.

As we review the results of the first 5 years of operation of the U.S. nuclear power program, it becomes evident that there is now need for a careful evaluation of the national effort and a determination of the program that should be pursued during its next phase. The project which we have undertaken to accomplish this evaluation has become known, both within the AEC and in industry, as the "10-year program." It is my purpose during the next few minutes to discuss

with you the status of this study and the conclusions which we have reached concerning the economic potential of the several reactor concepts which we now have under active investigation.

First, I would like to say a few words about the procedures which we have followed in carrying out the project. In order to develop any sensible long-range program, it was necessary tht we first have as a starting point a clear understanding of the current status of the several concepts which make up our current program. In addition, we need the best possible analysis of the potential of each concept, the scope and cost of the development, and construction program needed to achieve its potential, and the time when the potential could be realized.

We have now completed those phases of the study which establish the current status and which give us preliminary answers concerning the potential of each of the concepts. In developing this information, we have taken full advantage of the talents, knowledge, judgment, and know-how of persons within the Commission and its laboratories and from the U.S. nuclear industry. Based on the contributions of these persons and incorporating adjustments and evaluations made by the staff, we have prepared a report entitled "Summary of Current Status of Reactor Concepts." This report is now being printed and will be available for distribution early next year. We have also prepared a preliminary draft report entitled, "Economic Potential and Development Program." This report will be used by the Commission and its Ad Hoc Advisory Committee as one tool in the development of the long-range program. The information which I am presenting today is the first public discussion of the contents of this second report.

Before discussing the details of our analysis of the potential of the various concepts, I would like to spend a few minutes discussing just what was and was not covered in the study.

To begin with, we have considered only those concepts which have sufficient technical bases to allow us today to assume technical feasibility, and we have projected development programs only to the extent that it is reasonable, on the basis of our present knowledge, to foresee success. Aside from nuclear superheat, no major modification of concepts as we now know them was assumed.

For example, we have not attempted to introduce into these studies the effect of variable moderation or spectral shift on the potential of the water concept—we have not tried to factor in the long range effects of programs such as Turret or Pebble Bed on the gas-cooled concept—our analysis of the fast reactor systems did not attempt to give weight to the potential impact of the Los Alamos Molten Plutonium Reactor Experiment. We made no attempt to study the potential of other moderators such as graphite or D_2O when used with organic coolants; we did not analyze the use of graphite moderation in water systems; we made no attempt to determine the potential of epithermal reactor systems; the possibility of open- or closed-cycle gas-turbine systems was not evaluated. Furthermore, we made no assumptions that the current charges for reprocessing and transportation would be decreased, that waste-disposal techniques would be improved, or that there would be major cost reductions as a result of high volume throughout in fuel fabrication. I dwell on this subject in order that it be clearly understood that our studies and the figures which I give today were based on what seems to be the potential of these systems which have today progressed to the point where large-scale plants are in operation or will soon be. We have not projected ourselves into the realm of unproven concepts.

The studies which we have now undertaken and which I am discussing today are only the first in a continuing series. The omissions which I have discussed, together with others, will be factors into our future studies.

Now that I have, I hope, made clear what is not covered by the study, I would like to say a few words about the ground rules and assumptions which went into the study we did make. I do this so that you may better interpret the results and assign a confidence level to the figures which I will present. We have attempted to follow ground rules which are neither unreasonably optimistic nor unduly pessimistic. The extent to which we have achieved this balance is a matter of opinion and judgment, and I am sure we will be subject to criticism on both sides. If the number of critics on each side is roughly equal, I will assume that we have reached a reasonable balance.

Some of the assumptions that are on the optimistic side are:

1. All research and development and engineering test programs were successful.

2. A load factor of 80 percent was in effect.

Offsetting these factors are some which could well be considered to be pessimistic:

1. No credit is taken for such things as shorter construction times, lower engineering costs and lower component costs which will undoubtedly come about as the nuclear industry reaches its maturity.

2. All economics were based on a one reactor, one turbine station. No credit was taken for multiple unit stations such as are no wbeing built in England and Russia.

3. It was assumed that operating, maintenance and insurance costs would remain high for nuclear plants.

4. No increase in reactor capacity beyond design power was assumed, although experience has shown that reactors can generally develop much more than design power after they have operated for a reasonable time.

5. No decrease in the cost of uranium 235 was assumed.

In our studies, we have attempted to evaluate the several concepts on a comparable basis. It was, however, not possible to follow ground rules that offered complete consistency among the concepts. For example, by fixing the size of the reference plant at 300 electrical megawatts, we may have established a relative economic potential among the concepts which would not be the same had the reference plant been much larger. Variations in assumed value of plutonium or the assumed cost of uranium 235 would also have slightly different effects on different concepts, as would changes in the inventory charge for uranium or for heavy water. These factors are, however, all considered to be minor deviations in the detailed structure of our study. They do not affect the basic conclusions of our effort.

I would now like to discuss the details of our results on the various concepts. In each case, I will indicate the cost of power from a 300-electrical-megawatt plant that could be built with today's technology without major extrapolation, the areas where we have assumed cost reductions could be made, the extent of such potential reductions and hence the cost of power from the "potential plant," the cost of the additional research and development program which would be required to achieve the reduction and the date when construction could be initiated on the "potential plant." All cost data are based on an assumed 80-percent load factor, fixed charges at 14 percent, and plutonium value at $12 per gram.

I. Pressurized water systems

In this country, this system is at present the most technologically advanced as a result of the experience which has been gained in design and operation of the naval propulsion reactors, the Shippingport reactor, and the Fort Belvior reactor, in the design and construction of such units as the NS *Savannah*, the Dresden Nuclear Power Station, the Yankee Atomic Electric Co. reactor, Project Enrico Fermi of SELNI, Belgian reactor No. 3, the Saxton nuclear experimental reactor of the Nuclear Experimental Corp., Saxton, Pa., and the various Army reactors, and in the design studies on the small power and process heat reactors. It is not unreasonable, therefore, to find that the power costs from a 300 electrical megawatt pressurized water reactor that could be built with today's technology, namely 9.28 mills per kilowatt-hour, are lower than from any other type of reactor. This cost consists of 5.05 mills for capital cost, 3.38 mills for fuel cycle cost, and 0.85 mills for operation, maintenance, and insurance.

Our studies indicate that the substitution of primary pumps employing mechanical shaft seals rather than canned rotors, the elimination of external pressurizers, the modifications of the vapor containment, the use of bulk boiling, and the simplification and improvement of control drive mechanisms would allow a reduction in the total capital cost of the plant by 0.65 mills per kilowatt-hour, which makes that cost component for the "potential plant" 4.40 mills per kilowatt-hour.

More extensive reductions are indicated in the fuel cycle costs for this system. The fuel exposure for the uranium dioxide fuel can probably be increased from the 27,500 megawatt-days per ton maximum which is current technology to 40,000 megawatt-days per ton. We also think that fabrication costs of stainless steel clad uranium dioxide can be dropped from the "current' level of $110 per kilogram of uranium to $70 per kilogram. These two factors would result in a total reduction in the fuel cycle cost of 0.82 mills per kilowatt-hour which maks this factor in the "potential plant" 2.56 mills per kilowatt-hour.

We have assumed that the operating, maintenance, and insurance charges will remain at the 0.85 mills per kilowatt-hour level. The total cost for the power from the "potential plant" in the pressurized water system is thus 7.81 mills per kilowatt-hour.

In order to achieve the gains indicated above, a research and development effort of the order of $20 million will be required between now and 1965. We feel that by proper utilization of existing, or soon to be existing, plants, it would not be necessary to construct more experimental or prototype reactors over and above those now in operation, under consideration, or planned, and that a project aimed at construction of the "potential plant" could be initiated, concurrently with the research and development program, in the near future.

II. Boiling water systems

This system is today only slightly less technologically advanced than the pressurized water system. This is due in part, of course, to the fact that it is able to take advantage of much of the extensive experience and technology developed in the pressurized water system. It is also due to the highly successful operating experience of the experimental boiling water reactor, the Vallecitos boiling water reactor, and BORAX experiments, to the engineering experience that has been gained through design and construction activities of Dresden, Elk River, Northern States, Army reactors, etc., and through the design efforts on such units, as the SENN (Societa Elettronuclear Nazionale) Ponta Fiume plant, the Humboldt Bay project of the Pacific Gas & Electric Co., and others.

We have estimated that a 300 electrical megawatt dual cycle plant could be built on the basis of today's technology to produce power at a total cost of 9.61 mills per kilowatt-hour. This figure is made up of 5.26 mills for fixed charges, 3.47 mills for fuel cycle, and 0.88 mills for operation, maintenance, and insurance.

The capital costs factor of this system could be reduced by simplification of design to eliminate large risers and heat exchangers, by increasing the power density from 28 kilowatts per litre to 50 kilowatts per litre of core, and, by changes in the vapor containment design. The total potential reduction in the capital costs by these changes is 0.95 mill per kilowatt-hour, which brings that component of the "potential plant" to 4.31 mills per kilowatt-hour.

The reduction in the fuel cycle costs would be brought about by the power flattening which is made possible by high power density elements, by increasing the average irradiation of the fuel to 19,000 megawatt-days per ton, and by reducing the fabrication costs for the zirconium clad uranium dioxide from $140 to $90 per kilogram of uranium. The total potential reduction of the fuel cycle costs which can be brought about by these gains is 1.18 mills per kilowatt-hour which brings this part of the power cost of the "potential plant" to 2.29 mills per kilowatt-hour. Again, operation, maintenance, and insurance have been assumed to remain constant at 0.88 mill per kilowatt-hour and the total cost of power from the "potential plant" is 7.48 mills per kilowatt-hour.

In order to achieve these gains, a development program amounting to approximately $20 million must be undertaken in the next 5 years. In addition, it will be necessary to construct and operate a high power density prototype which will require an additional $25 million. Construction of the 300 electrical megawatt "potential plant" could start in late 1965 or early 1965.

III. Nuclear superheat

While it is not, in our opinion, possible to build a nuclear superheat reactor solely on the basis of today's technology, we feel that this concept offers a fair potential for reducing the cost of power from water reactors—either pressurized or boiling systems. In our study, we conclude that the cost of electricity from a 300 electrical megawatt water plant would be reduced by 0.73 mill per kilowatt-hour through the use of an integral nuclear superheat system. The cost reduction, which is split 0.43 mill for capital cost and 0.30 mill for fuel cycle, is due primarily to higher plant efficiency and reduction in turbine costs which is made possible by superheated steam. If these reductions are applied to the "potential plant" in the boiling system, a power cost of 6.75 mills per kilowatt-hour results.

In order to achieve the potential benefits of nuclear superheat, a development program, in addition to others discussed previously under water systems, of the order of $4 million must be carried out between now and 1965 and a nuclear superheat prototype reactor must be built and operated at a cost of approximately

$20 million during that period. A 300 electrical megawatt "potential plant" incorporating nuclear superheat could be under construction in 1965.

IV. Organic cooled and moderated systems

In this system, the state of knowledge is not as extensive as in the water systems and as a result the cost of power from a 300 electrical megawatt plant built on today's technology would be 11.45 mills per kilowatt-hour. This figure is made up of capital costs of 4.39 mills, fuel cycle costs of 5.72 mills, and operation, maintenance and insurance costs of 1.34 mills. The lower capital cost for this system, made possible because of its low pressure, noncorrosive aspects, is more than offset by the high fuel cycle costs resulting from the low exposure which can be achieved in the metal cores of current technology and by the high operating costs which are occasioned by the necessity for replacing the organic material as it is destroyed by reactor irradiation.

The potential of this system lies in the development of a new fuel element and cladding material which can achieve much longer life, in increasing the power density from 19 to 44 kilowatts per litre of core, and in increasing the heat transfer capabilities of the system. The studies which we have made indicate that the necessary results can be achieved and that the cost of power from the 300 electrical megawatt "potential plant" would be 7.10 mills per kilowatt-hour, of which 3.65 mills are due to capital costs, 2.11 mills to fuel cycle costs, and 1.34 mills to operation, maintenance, and insurance.

In order to achieve these results, it would be necessary to undertake a research and development program amounting to approximately $40 million between now and 1965. In addition, $30 million is needed for the construction and initial operation of a 75 electrical megawatt prototype reactor. Construction of the 300 electrical megawatt "potential plant" could be initiated in 1965.

V. Sodium graphite system

The operating experience of the sodium reactor experiment, together with the experience of the naval reactors and the fast reactors programs, has indicated that it is technically feasible to use the sodium graphite system to produce power. We have estimated that power costs from a 300 electrical megawatt plant based on current technology would be 11.22 mills per kilowatt-hour, of which 6.11 mills are for capital costs, 4.12 mills for fuel cycle, and 0.99 mill for operation, maintenance, and insurance.

In order to realize the potential of this system, it will be necessary to develop a new fuel material—the uranium-molybdenum elements on which current technology is based offer very little potential for reduction in fuel cost. However, by developing uranium carbide as a core material, by achieving a core life of 17,000 megawatt-days per ton, and by lowering fabrication cost for stainless-steel-clad uranium carbide elements to $70 per kilogram of uranium, the fuel cycle costs for this system would be reduced to 1.92 mills per kilowatt-hour.

In addition, by developing simplified and much less expensive steam generators, by confining the primary cooling system to the reactor vessel, by eliminating moving parts in the sodium stream, and by developing a calandria core to supersede the canned moderator core of current technology, it will be possible to reduce the capital costs of the plant by 1.19 mills per kilowatt-hour. It is also expected that increased knowledge of sodium handling systems will allow operating costs to be reduced by 0.05 mill per kilowatt-hour.

Taking into consideration all reductions which can reasonably be expected to be achieved, the cost of power from the 300-electrical-megawatt "potential plant" will be 7.78 mills per kilowatt-hour of which 4.92 mills will be for capital costs, 1.92 mills for fuel cycle, and 0.94 mill for operation, maintenance, and insurance.

To accomplish this program, a development program, including the operation of the Hallam Nuclear Power Facility and the Sodium Reactor Experiment, of the order of $82 million will be required between now and 1967. In addition $50 million will be required for construction of a 75-electrical-megawatt prototype reactor. Such a program would make it possible to start construction of the 300-electrical-megawatt "potential plant" by 1965 or early 1966.

VI. Gas-cooled reactor systems

Gas cooled technology in this country is not in a highly advanced position, since it is only quite recently that work in this field has become an important factor in our overall program. In spite of the fact that no gas-cooled power reactors have been built or are even in an advanced state of design in this country, we feel that British experience on natural uranium gas-cooled reactors, plus

the extensive development work which we have done in this country on enriched fuels, gives us the current technology on which we can base estimated power costs from a plant that can be built at this time. These costs are 11.89 mills per kilowatt-hour for a natural uranium gas-cooled reactor system and 10.36 mills per kilowatt-hour for an enriched system—this latter figure has a 5.97 mills component for fixed charges, 3.21 mills for fuel cycle, and 1.18 mills for operation, maintenance, and insurance.

Since our studies show that enriched systems have a greater economic potential than natural uranium systems under U.S. utility economics, we have not, at this time, attempted to determine the potential of the natural uranium fueled-gas-cooled systems.

For the enriched system, our studies indicate that by increasing the bulk outlet temperature of the system from 1050° F. to 1200° F., by increasing the system pressure from 300 to 400 pounds per square inch, and by increasing the power density from 5 to 8 kilowatts per litre of core, the capital cost component of the power cost could be reduced by 1.88 to 4.09 mills per kilowatt-hour.

As in the case of other systems, the basic reductions in fuel cycle costs are predicted to be due to lengthening life and reducing fabricating costs. In this system, it is estimated that the life could be extended from 10,000 to 14,500 megawatt-days per ton and that the fabricating cost for the elements could be reduced from $110 to $70 per kilogram of uranium. This would bring about a total reduction of fuel cycle cost of 0.40 mill per kilowatt-hour, to make this component of the cost of the "potential plant" 2.80 mills per kilowatt-hour.

A further cost savings is indicated if CO_2 can be substituted for He as the coolant. This would reduce operation and maintenance costs by 0.40 mill per kilowatt-hour. Based on all potential gains, the estimated cost of power from the 300-electrical-megawatt "potential plant" would be 7.67 mills per kilowatt-hour.

The costs of the development program necessary to achieve this potential is of the order of $100 million between now and 1968. This is exclusive of the $14,500,000 research and development program which is aimed at the high temperature unclad fuel prototype being constructed by Philadelphia Electric for $24,500,000. In addition, it will be necessary to construct the $30 million experimental prototype which has already been authorized and which is now under construction at Oak Ridge.

Construction of the 300-electrical-megawatt "potential plant" could be initiated by 1966.

VII. Heavy water moderated natural uranium systems

The practical technology of heavy water moderation for power-producing reactors is not far advanced in this country. However, the basic technology for this system has been developed through research and development programs, and much useful engineering and scientific technology in this field is available from the design, construction, and operation of the production reactors at Savannah River. In addition, a vast amount of basic and engineering information has been generated by the Canadians, who have placed major emphasis on this system. Taking all these factors into consideration, and recognizing that the figures do not have the same degree of back-up as those based on current technology for other systems, we have concluded that the cost of power from a 300-electrical-megawatt pressure vessel, nonboiling plant built on today's technology would be 12.50 mills per kilowatt-hour of which 7.05 mills are for capital cost, 4.22 mills for fuel cycle, and 1.23 mills for operation, maintenance, and insurance.

Because this system is in an early state of development, the potential gains which can be predicted with reasonable assurance are fewer in number and of less certainty than for other systems on which we have a greater background of current technology. However, we are satisfied that by the development of a pressure tube reactor instead of a pressure vessel type, and by achieving an increase in power density from approximately 26 kilowatts per litre, which we feel is currently possible, to 35 kilowatts per litre, we could reduce capital costs by approximately 0.56 mill per kilowatt-hour to a level of 6.49 mills per kilowatt-hour.

Our analysis also shows that it is reasonable to increase the exposure lifetime of the fuel from 3,850 megawatt-days per ton, assumed as possible with current technology, to 7,000 megawatt-days per ton during the next few years, and also to decrease the cost of fabrication from $50 to $15 per kilogram of uranium. These improvements would lower fuel cycle costs by 2.91 mills per kilowatt-hour to a "potential figure of 1.31 mills per kilowatt-hour."

We are not able to predict any decreases in operation, maintenance, and insurance below the 1.23 mills per kilowatt-hour level assumed for the current status plant.

The cost of power from the 300-electrical-megawatt "potential plant" is thus 9.03 mills per kilowatt-hour.

In order to achieve the gains indicated, it will be necessary, in addition to the program associated with the reactor project of the Carolina Virginia Nuclear Power Associates, to undertake an $80 million research and development program, between now and 1967, and also to undertake a construction program in the neighborhood of $175 million. Construction of the "potential plant" could be initiated in 1967 or 1968.

I am sure that all of you recognize that our evaluation of the potential of the heavy water natural uranium system is not completely consistent with that of the Canadians. In this respect, it must be recognized that our evaluation is based on U.S. economic conditions and that theirs is based on Canadian conditions. It must also be remembered that the "current technology" is much more firm in Canada—they are much more at home in this system than we are. The differences are matters of judgment, and only time and an intelligent program of research and development and plant construction will show which evaluation, if either, is correct.

VIII. Fast reactor systems

Technical feasibility of the fast reactor system has been demonstrated by operating experience of experimental breeder reactor No. 1. In addition, the design and development programs which have been carried out for experimental breeder reactor No. 2 and the Enrico Fermi atomic power plant have given us the basis of a current technology on which could be based the design of a 300-electrical-megawatt plant capable of producing power at a cost of 13.25 mills per kilowatt-hour. The components of this cost are 5.10 mills for capital cost, 7.10 mills for fuel cycle, and 1.05 mills for operation, maintenance, and insurance.

Capital costs may be lowered approximately 0.67 mill per kilowatt-hour by reducing the thickness of the reactor shield, by simplifying design of pumps and inert gas system, by improving and simplifying piping layout and fuel loading and unloading mechanism, by increasing the temperature rise in the reactor and the temperature drop through the intermediate heat exchanger and steam generator, by decreasing pump and pipe size, and by improvements in instrumentation.

Major cost reductions can be realized by substituting a cermet fuel for the uranium—10 percent molybdenum alloy which is the fuel of current technology. The use of such fuel would reduce fuel cycle costs from 7.10 to 1.99 mills per kilowatt-hour.

No credit is taken for lowering operation, maintenance, and insurance costs. Total cost of power from a 300-electrical-megawatt "potential plant" is 7.47 mills per kilowatt-hour.

In order to realize the potential gains of this system, it will be necessary to carry out a development program between now and 1968 in the amount of approximately $160 million, exclusive of money spent on the Fermi plant, and in addition to build a prototype plant at an estimated cost of $55 million.

The 300-electrical-megawatt "potential plant" construction could be started in 1968 or 1969.

IX. Thermal breeder—aqueous homogeneous systems

Our studies have indicated that technical feasibility of the aqueous homogeneous reactor system as a thermal breeder has not yet been demonstrated. I therefore will not discuss the cost of power from a plant based on current technology. However, there is a sufficient background of technology on this system to allow us to predict with, of course, somewhat less certainty than in other cases, the potential of this system. Power from a 300-electrical-megawatt "potential plant" is estimated to cost 11.33 mills per kilowatt-hour of which 6.38 mills are due to fixed charges, 2.12 mills to fuel cycle costs and 2.83 mills to operation, maintenance and insurance.

In order to achieve this objective, it is necessary to undertake a broadly scoped research and development program in the amount of approximately $75 million between now and 1970, and in addition to construct a 5- to 10-megawatt experimental reactor (breeder reactor experiment No. 3), a 110-thermal-megawatt thermal breeder experimental reactor, and a prototype reactor plant of 125-electrical-megawatt capacity. The cost of those plants is approximately $100 million.

On this schedule, it is possible that a 300-electrical-megawatt potential plant could enter the design and construction phase by 1970 or 1971.

Conclusions

From the studies which we have made, and with full recognition of the degree of uncertainty that is inherent in any cost estimates in this field, certain conclusions may be drawn:

1. No reactor system can be constructed on the basis of today's technology which can compete with power from conventional systems using fuel costing less than 54 cents per million B.t.u. In this and the following comparison, by the way, I am assuming a conventional plant of 300-electrical-megawatt capacity and a load factor of 70 percent.

2. Six of the reactor systems can become competitive with conventional plants using fuel costing in the range of 35 to 40 cents per million B.t.u.

3. Of the six systems which could compete in areas having conventional fuel costs in the range of 35 to 40 cents per million B.t.u., the pressurized water system could do so at the earliest date.

4. The potential of the water systems, with nuclear superheat, and the organic system is essentially equal from the standpoint of power cost, time when the potential can be achieved, and development costs needed to reach the goal. Other systems will require 1 to 4 years longer to reach their potentials and will require two to three times as much development effort.

In closing, I would like to emphasize once more that the studies which I have reported on here today represent only one small part of the continuing evaluation and analysis program which will play an ever-increasing part in developing our national nuclear energy program. The figures I have given and the conclusions I draw today are as important for what they leave unsaid as for what they say. The figures have all the uncertainties that are inherent in any predictions based on the results of experimental programs yet to be undertaken and on the operation of plants not yet built—or in many cases not yet even designed. In developing the figures, we were naturally forced to use a fair share of technical and scientific judgment. I can only hope and request that an equal degree of understanding and judgment is exercised by those who will use and quote the figures.

Mr. CANNON. Mr. Taber.

Mr. TABER. Mr. Chairman, it might be that you have answered this question before I came back in this afternoon.

PROGRESS BY OTHER NATIONS

To what extent has Great Britain progressed in the atomic field?

Mr. MCCONE. Mr. Taber, from my observations, and I have made several trips to Great Britain examining their installations, both military and civilian, they have made very significant progress. In the military field, prior to any exchange of information with us or any access to our weapon development, they reached quite a high level of competence, including the development of Hydrogen bombs of megaton size, as well as smaller fission bombs.

In the field of nuclear power, they first concentrated on one particular reactor concept and have built or are building several plants, all essentially identical in design. This serves a particular purpose for Great Britain, because of their unique fuel situation. It would be of no value whatsoever to us, because we have enjoyed cheaper fuels and the plants that they are building would not be competitive as power producers in any area of the United States. They have reached the point now they find that this particular plant design of the Calder Hall type, they have carried to the ultimate, and therefore they are developing higher temperature and more advanced designs and are considering still further designs.

I would say that although their program is smaller as compared to ours, in both the military and civilian fields, they have advanced remarkably well and of course from the standpoint of the production of kilowatts, which I feel is no particular measure of progress, it is a measure of a country meeting its own unique situation, they exceed any other nation in the world. Because of changes in the fuel situation which have taken place over the last few years, they have reevaluated their program and I understand stretched it out somewhat. Since I last appeared before this committee, I have, as you know, visited the Soviet Union with several of our scientists and made a thorough examination of their program. We were very much surprised to find their program was much more limited than we had expected from the standpoint of the building of power producing units. The reports which had been rather freely circulated at Geneva overstated their situation. I am afraid the New York Times or the Herald Tribune, whichever article the chairman quoted from, erred in their report. They have a very substantial research and an impressive research and development effort. I think in terms of numbers of scientists and engineers it is comparable to the size of our own. In terms of the translation of the work of the laboratory into power producing units, they are far behind us in terms of breadth of their program.

Mr. TABER. Did you go into the Russian military aspects, so that you would be able to tell us something about their military progress in connection with the atom?

Mr. MCCONE. No. My visit did not involve any of the military aspects of the problem. However, it was abundantly clear to us from an examination of the work they were doing in their laboratories on civilian or peaceful uses that they possess a high level of technical competence, and therefore there is no reason to doubt their ability to go forward in the various military fields at a level determined only by the amount of effort they want to, as a matter of policy, put into this program.

Mr. TABER. Has Great Britain made a great deal of progress along the military lines?

Mr. MCCONE. I think she has. We were quite surprised to find the level of their competence. On the other hand, I am quick to say that the exchange of weapons information under the bilateral that was consummated a little over a year ago was very helpful to them. We have secured from them information in special fields that have been of value to us.

Mr. TABER. There is no reason to believe that they have not given you all the information that they possess?

Mr. MCCONE. I would like General Starbird, if he is here, to answer that question. He is closer to it than I have been.

General STARBIRD. We have been quite careful under our law, Mr. Taber, to only transmit to them what we felt they needed. Our law provides there must be such a limitation on what we send. We therefore have avoided asking for things that we did not need. However, never have we asked for any information from them, indicating that we are interested in something, that they have not given it to us. I personally believe that they have given us everything that would be of usefulness to our program.

Mr. TABER. What is the attitude of France along that particular line?

Mr. MCCONE. The attitude of France is this. They feel that they are on the threshold of acquiring a nuclear capability. They have been successful in two test devices in the Sahara, and you are familiar with those. They have completed their plutonium production facilities, and the facilities are now in operation.

(Discussion off the record.)

Mr. MCCONE. Their plants are only now going into production. I think that their resource of fissionable material is now being used for their testing program as well as for the necessary laboratory work, but they will soon be able to accumulate some weapon capability and this will grow progressively over the years.

To get ahead, they will have to test, and they are planning on further tests, probably underground. While I was there last week, their Defense Ministry was exploring sites in Corsica, and, I am told, in Madagascar, as well.

Mr. CANNON. Off the record.

(Discussion off the record.)

EMPLOYMENT BY AEC AND CONTRACTORS

Mr. TABER. How many people do you have employed in your activity?

Mr. MCCONE. Our own payroll?

Mr. TABER. The whole group.

Mr. MCCONE. There are 110,000 working for contractors, and there are about 7,000 on the Atomic Energy Commission direct payroll.

Mr. TABER. The rate of pay is higher on the contract employees than otherwise?

Mr. MCCONE. I would say that is generally correct, that the rate of pay of contractors is somewhat higher than for the Government employees.

EMPLOYMENT BY OTHER NATIONS

Mr. TABER. What can you tell us about the number of people who are employed by Great Britain in its activity?

Mr. MCCONE. I do not know the total number.

Mr. TABER. Is that available?

Mr. MCCONE. It would be very difficult to get a comparable figure, because they are organized differently.

Mr. TABER. Do they operate through contractors, the same as you do, or do they carry on their operations directly?

Mr. MCCONE. Their laboratories, which we operate through contractors, they operate directly. However, the manufacturing operations are handled to a certain extent as we do, through contractors, although there are some areas of weapon manufacture which they handle with Government employees that we handle through contractors.

Mr. TABER. Now, I do not expect you to have any idea at all about the Russian picture.

Mr. MCCONE. I have no idea whatsoever about the total employment. There are no contractors, of course. Their laboratory effort in the fields of our interest seem to be comparable in size to ours.

Mr. TABER. Their laboratory activity is comparable to ours?

Mr. MCCONE. Comparable in size to ours. That was the conclusion we reached from our trip over there, and visiting any number of laboratories.

PROGRESS BY OTHER NATIONS

Mr. TABER. You did tell us that the Russian setup was not as far advanced so far as these powerplants are concerned as ours.

Mr. MCCONE. That is correct.

Mr. TABER. Is it as far advanced as the British?

Mr. MCCONE. No. It is more diversified. It is a broader development program than the British, but not so far advanced.

Mr. TABER. They perhaps might be as far advanced as the British in connection with such things as the warhead and that sort of thing?

Mr. MCCONE. I do not know.

Mr. TABER. You would not want to say?

Mr. MCCONE. I would not want to say; no.

Mr. TABER. What about the French?

Mr. MCCONE. They are more advanced than the French quantitatively and qualitatively.

Mr. TABER. I think that is all I have.

LOCATION OF RUSSIAN LABORATORIES

Mr. CANNON. Have you any definite ideas, Mr. Chairman, about where their laboratories are located?

Mr. MCCONE. Yes, I think we visited all of their principal laboratories, Mr. Chairman. We visited two in Leningrad, their large Atomic Energy Institute at Moscow, which compares in size to our Argonne Laboratory, and we visited their Institute of High Energy Physics, in Moscow, then their large high energy physics laboratory at Dubna, and their power development laboratory at Orninsk. We were told and we were invited to visit their work at Kiev and Sukini and also one point in Siberia, but time did not permit us to visit those laboratories.

Mr. CANNON. Off the record.

(Discussion off the record.)

Mr. JENSEN. I have some questions.

Mr. CANNON. Mr. Jensen.

TYPES OF CONSTRUCTION OF REACTOR PLANTS

Mr. JENSEN. Mr. McCone, you and your staff are before us again. Since I saw you the last time, I, along with some of my colleague, have visited some of your plants throughout the Middle West and West. I must say that we were greatly impressed by the men who were in charge of those plants, your people as well as the people in private enterprise who are building a number of those plants. We went to Monroe, Mich., to the PRDC plant. Everybody was very well pleased with the progress being made. We spent considerable time there, and as laymen we did learn a number of things. Of course, for a common layman to get his teeth solidly in this atomic energy field is no small job. Nevertheless, as time goes on, I can start to understand it. We were at Nebraska, and there you have an entirely different type

of construction than we saw at other places. In looking at the building that is going up, which must be pretty well completed by now, you would imagine you were looking at some kind of factory built along the lines of a big box, so to speak, and the container for the power will be buried in the ground. I could not help but feel that that was more practical construction than these spheres.

My question is, Is it much cheaper to build such type construction than a sphere, and is it just as good? Does it answer every purpose that a sphere does?

Mr. McCone. It is a matter of basic design. The Dresden plant in Dresden, Ill., is a sphere.

Mr. Jensen. I am thinking of Hallam, Nebr.

Mr. McCone. Hallam is a much smaller plant.

Mr. Jensen. I realize that.

Mr. McCone. It is a matter of designing a plant that any fission product resulting from a maximum possible accident would be contained in a containment vessel or containment shell. In the larger plants the sphere seems to be the most economical means of accomplishing this. Although there is a new and different process of vapor suppression that is now being proposed for the Humboldt Bay plant in California, and is now under final test and if these tests are finally to prove that the system is safe, then that might be a further step away from the sphere.

Mr. Jensen. What type of construction do they have there?

Mr. McCone. What is planned there is a system of arranging so that any gases which might result from a burndown of the core as a result of an accident would be discharged from a rather small concrete box, so to speak, around the reactor, would be discharged down into a pool of water and would be condensed there. Now, the question is whether total condensation will take place. This is being proven by an experimental model in which components will be in full size so it won't be a matter of extrapolating results in order to determine the adequacy of the condensation system.

Mr. Jensen. Well, then, it seems to me that this container, which is a sphere, could well be built in a square or other shape that is less expensive than building a spherical shape and be buried in the ground, even quite some depth, and by so doing the earth, itself, would act as a containment against possible explosion. Also by burying the core deep in the ground, you would get away from the danger of enemy bombing to a very great degree. When you see those silver spheres, wherever they are, it almost invites a possible enemy to say, "Well, they have certainly made it easy for us; they have put it right out here in the open where we can take a good crack at that."

I just do not understand, Mr. McCone, why we must build those great silver balls above the ground at a terrific cost, surely more than the cost to bury them deep in the ground with maybe 6 or 8 feet of concrete around the core. I, of course, was never in that kind of building game, but I was in a small degree in the building game for 3 or 4 years, and I have learned a little about construction, and I never have had that question answered to my satisfaction. Why don't we bury these atomic reactors and their containers deep in the ground? In fact, bury the whole building deep in the ground. Why, the cheapest kind of construction is excavation. They could even go

in and bury them in solid rock. We blast rock in nothing flat, and at not too much expense. Why don't we bury them in solid rock?

Is there a good answer?

Mr. McCone. Yes; there is a good answer. This gets into a wide range of engineering and economic considerations and I will say that containment is one of the problems in the construction of a nuclear powerplant that, first, must be done properly and, secondly, must be done as economically as possible in order to bring down the cost of nuclear power. The engineering firms that are involved in this business, such as General Electric, Westinghouse, and Atomics International, and so forth, as well as the construction companies and the Commission staff, itself, are working continously on this problem. Now it is not beyond possibility that there will be times when a subsurface building is a proper and most economical thing to do. That cannot be said at all locations because excavations to house a new powerplant must be very deep indeed. You run into serious water conditions, and then you have the problem of getting river water in for the cooling and all the rest of it. There are other locations, however, and there is a plant right now under consideration in which the Engineers are considering as one of the alternates the building of a substantial part of the plant underground. As far as the ground, itself, serving as a containment medium, I do not think this would be acceptable to meet our safeguard standards. We must contain these fission products with absolute assurance that they will not get out and be distributed over the neighborhood and contaminate the whole countryside.

Mr. Jensen. It would be much simpler and much cheaper to build in an excavation than to build these great expensive spheres. I will venture, Mr. McCone, and gentlemen, that within 10 years there will be no atomic enery reactor plants built above the ground.

Mr. McCone. That may be.

Dr. Wilson. It won't be because they are cheaper. They may go underground, but it won't be because it is cheaper.

Mr. Jensen. There are a lot of reasons. The other reason is safety reasons against bombing.

Dr. Wilson. You still have to have your containment.

Mr. Jensen. I know, but you have it there underground. I just can't accept any argument against it, because it is just so practical. Here we are spending about $45 billion a year for the Atomic Energy Commission and the military defenses, and we build our great atomic reactors right out in the open. You can see them so far away with the naked eye that an enemy bomber could really fix them quick. Even though it costs more, we are spending $45 billion a year approximately for the defense of this country and yet we say, "Here, Mr. Enemy, is our great atomic reactor plant producing plutonium and everything else, for war purposes, commercial purposes. Take a shot at it any time you want. Here it is out in the open for you." It does not make sense to me.

Mr. McCone. Yes, but we are building airfields out in the open. We are building all kinds of military installations out in the open. What you were looking at at Dresden was a powerplant for developing power in the Commonwealth Edison grid. It was 1 of 18 or 20 powerplants that they have on that grid, and every single one of them is above

ground. The production of plutonium is incidental and from the standpoint of our war effort may be considered insignificant. There are so many, many vital installations that are essential to our war effort that should go underground before we would put a nuclear powerplant—you talk about putting the Hanford reactors or Savannah reactors underground, that is a different story. But there is no use in my opinion in putting the Dresden plant underground from the standpoint of its invulnerability to attack, and leave our production plants at Oak Ridge and Savannah River and Hanford above ground.

Mr. JENSEN. No, but there will be a lot more of atomic reactor plants built in the future. I hope that a lot of thought will be given to that question, should we build these plants above the ground or underground.

Mr. MCCONE. Now, should we build ordinary commercial, conventional powerplants underground? They all serve the same purpose.

Mr. JENSEN. I will never forget in 1940 I went to Panama, and we flew over the isthmus. There are observation stations which were spotted at regular intervals on each side of the canal. War was imminent. What color were they painting all those observation stations and buildings? Aluminum. I said, "For heaven's sake, get these things camouflaged. Camouflage everything you can around this place." And it was done. Now, there are some things that to me are just ordinary good common horsesense. Why invite the enemy to have a clean shot? If we are in such danger of being bombed as some people think we are, surely we must feel that there is a danger from atomic bombing or we would not be spending all this money to defend ourselves and to bring about all the defensive program we have, as well as the offensive, in case of attack.

CANCER TREATMENT AT LAWRENCE RADIATION LABORATORY

I was greatly impressed when I visited the University of California laboratory. Dr. John Lawrence stayed with me the whole day. I saw an old lady 72 years old take a treatment for cancer. She was supposed to be dead 6 months ago, but she told me as she was laying there ready to take the treatment, "I want to visit with you after I get off this table." And I, along with Dr. Lawrence and a number of his staff, watched the treatment through a heavy plate glass window.

After the treatment, there was no feeling to it at all, as she explained to me, she got off that table and came out, walked down the stairs. She said, "I have nothing but praise and thanksgiving for these great doctors. Look at me. I had spent a lot of money and the doctors gave me up 18 months ago, and said I had 1 more year. I was supposed to be dead 6 months ago, but look at me now." It was the most encouraging thing I have experienced in years.

As I remember, they said they treated 132 patients there, and they had helped many of them and hurt none of them. So I ask, Mr. Chairman, that Dr. Lawrence be brought here, and I believe you gave your consent; did you not?

Mr. CANNON. We shall be glad to hear him. He will be here tomorrow.

Mr. JENSEN. That is wonderful. I asked if he would like to appear before the committee, and he said he would be very happy to do that.

So he is coming. He is a great man. I know the committee will be happy to hear him.

Now, I have a little statement here, and then I will ask two or three questions.

GOVERNMENT COMPETITION WITH INDUSTRY

Mr. McCone, in connection with the Bureau of the Budget Bulletin 60–2 regarding the elimination of Government competition with industry, I have been extremely interested in a recent exchange of communication between the AEC and several national business organizations on the subject of increasing private industry's role in the Government atomic energy program. In reviewing the Commission's February 10 response to these organizations, I am happy to see a clear statement of AEC policy to the effect that the Commission has maintained a firm policy to procure goods and services from private industry wherever practicable. It seems to me that how the AEC implements this policy will have an important bearing on the degree to which you will fulfill one of the major objectives of the Atomic Energy Act of 1954, that of strengthening free competition in private enterprise. I don't understand all of the technical material appended to your reply but several important things concern me and these are:

There appears to be a lack of uniformity in carrying out the Commission policy. I even get the impression that some of the Government-owned installations can and have made decisions in this area that actually conflict with the Commission policy. There appears to be little or no supervision of what the various Government-owned installations do to facilitate maximum procurement from private facilities.

On page 3 of the Commission's February 10 response the criteria of one of AEC's major contractors regarding procurement from private facilities is spelled out. I hope the Commission's citing of this criteria does not mean concurrence with it because it seems extremely vague and even somewhat contradictory with the objective of maximum procurement from private facilities. Yet nowhere do I find AEC's own criteria, and this concerns me greatly. In connection with the subject, I would like to know: Has the AEC issued any written instructions to all Government-owned atomic energy installations, spelling out specifically how they are to pursue the Commission's policy to procure goods and services from private industry wherever practicable. If so, please submit such instructions for the record. Would you like to comment on it now?

Mr. McCone. Yes, I would like to submit such instructions and such procedures and policies of the AEC for the record. It is our policy to procure goods and services from private industry where obtainable, and wherever possible within reasonable limits. We considered the example cited by communications from industry—industrial associations—very carefully and responded in each instance to them. There were a great many of them in which it was not possible for reasons explained to turn to private industry. There were other instances where they had indicated we did not employ private industry where they were in error and we did; and there were a number of instances where we were able to clear up misunderstandings.

I feel that this is a matter that the Commission gives continual attention to, and must, because we are in a transitory period; and in

the passage of time the expansion of private facilities for supplying our needs, and with it the expansion of the nuclear power industry, particularly, there is increasing opportunity to employ private industry. That is our intention and that is the course that we are pursuing. As far as details of the instruction, I will supply them to you.

(The matter referred to follows:)

AEC INSTRUCTIONS REGARDING PROCUREMENT OF SUPPLIES AND SERVICES FROM PRIVATE INDUSTRY

Office memorandum

U.S. GOVERNMENT,
June 24, 1955.

To: Heads of divisions and offices, Washington.
Managers of operations.
From: K. E. Fields, General Manager, R. W. Cook, Deputy.
Subject: Commercial-industrial activities of the Government providing products or services for governmental use.
Symbol: CS: GCT.

Attached for your information and guidance is a copy of Bureau of the Budget Bulletin 55–4, dated January 15, 1955. This bulletin initiates a review of those commercial-industrial type activities conducted by the Government that provide services or products for its own use which could be procured from private enterprise through ordinary business channels. It also sets forth Government policy with respect to both the starting and carrying on of such activities.

The purpose of this memorandum is to (1) restate AEC policy in this regard, (2) inform you concerning steps which have already been taken to comply with Bulletin 55–4, and (3) establish procedure for handling requests for exception under paragraph 2 of the bulletin.

1. *Policy.*—Existing AEC policy is consistent with the policy set forth in Bulletin 55–4. As stated in the AEC Guide for Contractors (May 1, 1952), "It is the policy of the Atomic Energy Commission to utilize to the fullest practicable extent the services of private enterprise in carrying out the various programs which the Congress has entrusted to the Commission."

2. *Steps already taken.*—

(*a*) In compliance with paragraph 3 of the bulletin responsibility for direction and coordination of this program throughout the AEC has been assigned to R. W. Cook, Deputy General Manager.

(*b*) The inventory required under paragraph 5 of the bulletin is being developed by the Controller principally from data available in the Washington office.

3. *Exceptions.*—Each case involving a request for exception to the policy stated in paragraph 2 of the bulletin shall be referred through channels to the Deputy General Manager for decision. Such cases shall be accompanied by a full and complete supporting justification.

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D.C., January 15, 1955.

Bulletin No. 55–4.
To the heads of executive departments and establishments.
Subject: Commercial-industrial activities of the Government providing products or services for governmental use.

1. *Purpose.*—This bulletin initiates a review of those commercial-industrial type activities conducted by the Government that provide services or products for its own use which could be procured from private enterprise through ordinary business channels (hereafter called commercial activities). It also sets forth Government policy with respect to both the starting and carrying on of such activities.

The fact that this bulletin does not deal with products or services provided directly to the public in no way relieves the agencies of keeping such activities under constant review and reevaluation as to the need for the Government to carry on such activities. The results of such reevaluation will be reflected in the legislative and budget programs.

2. *Policy.*—It is the general policy of the administration that the Federal Government will not start or carry on any commercial activity to provide a service or product for its own use if such product or service can be procured from private enterprise through ordinary business channels. Exceptions to this policy shall be made by the head of an agency only where it is clearly demonstrated in each case that it is not in the public interest to procure such product or service from private enterprise.

3. *Responsibility.*—In furtherance of this policy, the head of each agency shall give personal direction to the accomplishment of the review (inventory and evaluation) of the activities of his agency which wall within the scope of this bulletin. He shall assign to a member of his key staff the responsibility for direction and coordination of this program throughout the agency.

4. *Scope and coverage of review.*—The review will consist of two phases: (*a*) An immediate inventory of all commercial activities, and (*b*) an evaluation of these activities, to be spread over a longer period of time. The first evaluation will cover manufacturing activities as set forth below. This will be followed periodically by similar evaluations of other commercial activities, such as wholesale and retail trade, repair and business services, construction, transportation, communication, public utilities, agriculture, forestry, fisheries, and mining. Instructions for later evaluation reports will be issued subsequently, but agencies may proceed with a program of evaluation and action as fast as time permits.

The following rules will prevail as to coverage of the review:

(*a*) The review will cover activities carried on in the continental United States and in the Territories of Alaska and Hawaii.

(*b*) In determining whether an activity is "commercial" in nature and "could be procured * * * through ordinary business channels," reference may be made to the "Standard Industrial Classification Manual" and to ordinary business practice with respect to procurement of services or products. The inclusion of an activity in the manual will be generally considered indicative that it may be procured commercially. There will be excluded from coverage as noncommercial, however, those functions which are a part of the normal management responsibilities of a Government agency of a private business of comparable size (such as accounting, personnel work, and the like).

(*c*) Any activity at any one location which involves an equipment investment of less than $5,000 and a product or service with an approximate annual value of less than $25,000 shall be excluded.

(*d*) "Activities conducted by the Government" will exclude Government-owned contractor-operated facilities as far as evaluation is concerned, but will include such facilities for purposes of the inventory report.

(*e*) "Activities * * * for its own use" will include the activities of producing a service or product primarily for the use of the Government (whether the same agency or other agencies), even though some portion of the product or service is sold or given to the public. The coverage will include activities which are to provide a service or product for the use of a Government agency in its official duties, even through the agency is engaged in carrying out a service to the public (e.g., it will include the manufacture of mail bags or the generation of power at a Government institution). However, the coverage will exclude the activities of producing a service or product primarily to be sold or given to the public (e.g., it will exclude the generation of power for sale to the public).

5. *Inventory of commercial activities.*—Each agency shall prepare an inventory of all commercial activities. The inventory shall identify the activity in terms of the "Standard Industrial Classification Manual," the number of installations or the locations where the activity is conducted, the capital assets invested in the activity, and the average number of employees engaged in the activity. Exhibit 55–4A indicates the format for reporting this inventory to the Bureau of the Budget. Instructions for this report are contained in attachment A.

6. *Evaluation of manufacturing activities.*—Each agency shall make an evaluation of all its commercial activities which are classified as manufacturing in the inventory. Government-owned, contractor-operated activities included in the inventory report required under paragraph 5 above are not required to be evaluated at this time.

The evaluation should determine whether or not each of these manufacturing activities should be continued by the Government in the light of the objecives stated in paragraph 2 above.

The relative costs of Government operation compared to purchase from private sources will be a factor in the determination in those cases where the agency head concludes that the product or service cannot be purchased on a competitive basis and cannot be obtained at reasonable prices from private industry. In those cases it will be necessary to develop detailed data on such costs. In doing so, the costs of Government operation should be fairly computed and complete, covering both direct and indirect costs, including elements not usually chargeable to current appropriations such as depreciation, interest on the Government's investment, the cost of self-insurance (even though it is unfunded); there shall also be added an allowance for Federal, State, and local taxes to the extent necessary to put the costs on a comparable basis. Care must also be exercised to see that the costs of procuring material from private sources are fairly computed and complete, being truly representative of the lowest price the Government would pay for the quantity and quality needed, and taking account of any applicable indirect costs of the Government for such procurement.

The evaluation will also review the legal authorization for each activity and determine whether congressional action is necessary to permit discontinuance. Except where such congressional action would be required, activities should be discontinued as soon as the agency head determines that it is reasonably possible to do so. Where congressional action would be necessary to permit discontinuance, the agency head shall seek such action promptly, submitting drafts of legislation or appropriation language, as may be required, to the Bureau of the Budget in the usual manner.

The evaluation should proceed promptly so that a report of the results may be made as provided in paragraph 9 below. The report on each manufacturing activity conducted during any part of fiscal years 1954 and 1955 shall be submitted on exhibit 55–4B, showing what the agency head decides to do about the elimination, curtailment, or continuation of each activity. The form is divided into three sections. Section A shall be completed on all reportable activities. Section B shall be completed on those activities which are being curtailed, eliminated, or procured from commercial sources. Section C shall be completed for all activities which will continue as Government operations. Applicable questions only need to be answered. The justification for continuation as a Government operation must be complete. Instructions for this report are contained in attachment B.

7. *Applicability to Department of Defense.*—Inasmuch as the Department of Defense started its own review of these activities some months ago, special instructions will be issued for that Department in order to take full advantage of the work already done.

8. *Questions and interpretations.*—Any questions regarding completion of the forms or interpretation as to coverage should be presented to the respective Bureau of the Budget examiners.

9. *Reporting dates.*—The name of the individual designated to direct the program and three copies of whatever implementing instructions are issued by the agency shall be furnished the Bureau of the Budget by February 15, 1955. Three copies of the inventory reports (exhibit 55–4A) shall be submitted to the Bureau of the Budget on or before April 15, 1955. Three copies of the reports on evaluation of manufacturing activities (exhibit 55–4B) shall be submitted to the Bureau of the Budget on or before July 15, 1955. Copies of the evaluation report form may be secured in limited quantity from the Bureau of the Budget Publications Unit, code 189, extension 616.

By direction of the President:

ROWLAND R. HUGHES, *Director.*

ATTACHMENT A

To Bureau of the Budget: Bulletin No. 55–4

INSTRUCTIONS FOR INVENTORY REPORT ON COMMERCIAL ACTIVITIES

Prepare the report on letter-size paper in the format appearing on the reverse.

A separate report shall be submitted for each bureau, service, or other major administrative unit within the agency.

List on separate pages and designate appropriately (*a*) those activities or services which are Government operated, and (*b*) those which are Government owned but contractor operated.

Include all commercial activities conducted during any part of fiscal years 1954 or 1955.

Column 1: The type of activity or service should be classified according to the Standard Industrial Classification Manual (obtainable from the Superintendent of Documents), giving the industry classification number and the industry title as shown in the manual, and be followed by such additional words or phrases as will help to identify the specific activity or service. Where a major installation is itself a commercial activity and has a number of commercial activities as components, the installation should be listed by its overall functions and the component activities listed under it. Number each major activity consecutively beginning with the figure "1" on each page.

Column 2: If the activity is confined to one or a few locations, list them individually. If there are many locations, the number of separate facilities will be sufficient if accompanied by some general indication of locations.

Column 3: Estimate the value of capital assets used primarily for the activity. Use only one figure for the total of land, buildings, and equipment. Use same figures as reported to the General Services Administration in its Inventory of Federal Real Property Holdings, to the extent possible. For those activities not covered in the General Services Administration report, use same valuation basis (original cost) as used for that report.

Column 4: Show the average number of persons employed annually on the particular activity. This figure can be computed by averaging the figures reported to the Civil Service Commission on Standard Form 113. If the operation is seasonal, show the average employment for only the months during which the activity was performed and indicate in parentheses the number of months during which the activity was performed.

Column 5: Use this column for any special information considered pertinent from the standpoint of the development of an inventory. Do not try to justify the conduct of the activity here. Wherever necessary, justifications will be developed through subsequent surveys.

EXHIBIT 55–4A

Page No. ____ of ____ (total)

Inventory report of commercial activities under Bureau of the Budget Bulletin No. 55–4

Date _____

Check one

☐ Government operated.

☐ Government owned, contractor operated.

Agency _____ Bureau _____

Activity	Location or number of installations	Capital assets	Number of employees	Comment
(1)	(2)	(3)	(4)	(5)

ATTACHMENT B TO BUREAU OF THE BUDGET BULLETIN NO. 55–4

INSTRUCTIONS FOR EVALUATION REPORT ON MANUFACTURING ACTIVITIES

Section A. This section is to be filled out on all manufacturing activities. Answer only those questions which are applicable.

1. Use the industrial title from the Standard Industrial Classification Manual which describes the activity at the highest organization level that can be analyzed as a separate commercial activity, even though it may have a number of commercial activities as components. For example, a shipyard would be the industrial activity and not the individual activities which make up a shipyard, such as foundries, machine shops, etc.

2. Use the code number corresponding to the title from the Standard Industrial Classification Manual.

3. Refer to the proper page and line of the agency's inventory report previously submitted.

4. This should be the number of similar installations. Exclude those reported elsewhere as a part of another major activity.

5. If there are relatively few such installations, give their location. If there is a larger number of such installations, use some descriptive term, such as "at all dam construction sites" or "one in each seaboard State."

6. Show as subordinate activities the types listed in the Standard Industrial Classification Manual which form a part of the major activity listed in No. 1.

7. This should be an estimate of the total expenditures attributable to the activity for the fiscal year 1954.

8. This should be an estimate of the total expenditures attributable to the activity for the fiscal year 1955.

9. Show the number of employees assigned to the activity who were included on the standard form 113 report to the Civil Service Commisson and the number of military personnel assigned to the activity.

10. If the number of employees shown in No. 9 is not representative of the normal or seasonal size of the operation, explain the seasonal character and give figures which reflect the maximum employment during the peak season.

11. On a percentage basis, account for the disposition made during fiscal year 1954 of the products manufactured.

12. The value of land and buildings should be the same (initial cost) as reported to the General Services Administration in connection with its survey of real property holdings. For those assets disposed of before or acquired after December 31, 1953, which are not included in the GSA survey, use the same concept of initial cost, or the best estimate thereof, in setting the asset figure. This concept should also govern the value placed on equipment which was not covered by the GSA survey.

13. Check the block which indicates the authority and circumstances under which the activity is conducted. If it is required by law check "Required." If it is specifically authorized but not required by law, check "Specifically authorized." If it is not specifically authorized or requird but has been the subject of specific congressional approval in appropriation acts or some other legislation, check "Congressional approval" and explain the circumstances. If there is no specific approval, but the agency considers that its basic legislation authorizes the activity, check "General authorization." Use the "Other" block only if none of the previously mentioned categories is applicable, and explain the circumstances. Wherever there is legislation under which the activity is authorized, give the United States Code citation.

14. Indicate by a check what the agency head determines is to be done about the continuation of the activity. Check the block "Eliminate" if the Government operation is to be closed and the facilities disposed of. Check "Curtail" if the volume of activity is being reduced but the activity will continue as a Government operation. "Continue" will be used to denote the decision that it is in the public interest for the activity to be conducted as a Government operation. Check "Other" if the activity is being converted to a contractor-operator basis or some combination of ways of procuring the product. If the "Other" block is checked, give a brief explanation of what is to be done.

Section B. This section should be completed for all activities on which No. 14 is not checked "Continue."

15. State exactly what is to be done.

16. Show the date on which the activity has been or will be eliminated, curtailed, or otherwise modified.

17. If the agency head's detremination is not yet in effect, indicate the extent to which negotiations or other actions have progressed on the date of the report.

18. If the agency head's detremination cannot be carried out because of existing law, summarize any legislative proposals being submitted to the Bureau of the Budget.

19. If the assets which were used in the conduct of the activity are to be sold or otherwise disposed of, so indicate. If they are not to be disposed of, give reasons.

20. If any of the assets have been disposed of, show the amount recovered from their sale. If they have not been but will be later, indicate an estimated amount to be recovered, adding "estimate."

21. Use the same basis for determining the value of the assets being retained as was used in estimating the value of the capital assets in No. 12.

22. There will normally be an entry on line 2 and, in addition, there may be one on lines 1 or 3, depending on the action being taken. The first line should show savings. The second should show amounts formerly spent for Government operations which hereafter will be spent for procurement of the product by direct purchase or contractual arrangements. The third line should show any increase in out-of-pocket costs of procuring the product, whether or not additional appropriations will be requested. The last line will be used for any other circumstances which will prevail. These need not be exact figures developed by a cost study but may be estimated amounts.

23. The changes in the numbers of persons engaged in the activity will be related to the answer on No. 9. The number eliminated does not necessarily mean that employment of the particular individuals will be terminated but it does mean that the personnel requirements of the agency will be reduced to that extent so far as the activity is concerned.

Section C. This section is to be completed whenever the agency head decides that the activity is to be continued as a direct Government operation.

24. This justification must be complete, showing the reasons why the agency head has decided that there is a clear demonstration that it is not in the public interest to procure such product from private enterprise.

25. If unavailability of the product commercially is a reason given in No. 24, this item will be used to indicate the circumstances under which the product is provided by private enterprise under normal business conditions. It should also indicate whether the geographical location of the activity is such that private enterprise is not in a position to fill the agency's needs. This should be answered only after specific analysis of the problem and must include a description of the steps which the agency has taken to be sure that private industry either can or cannot furnish the agency's needs.

26. If cost is a reason given in No. 24, this item will be used to indicate the comparative costs. Since cost should not usually be the deciding factor in determining whether to continue the operation as a direct Government operation, this statement should show both the results of the comparative cost analysis and the elements which have been used in determining the Government cost, both as a direct operation and if the product is secured from private industry.

EXHIBIT 55-48

EVALUATION REPORT UNDER BUREAU OF THE BUDGET BULLETIN NO. 55-4
ON GOVERNMENT OPERATED MANUFACTURING ACTIVITIES

(AGENCY) (BUREAU) (DATE)

ADDITIONAL INFORMATION WILL BE SUPPLIED BY SUBMITTED BY: (SIGN) _____

NAME _____ _____ (TITLE)

TITLE _____ TEL. NO. _____

SECTION A (TO BE COMPLETED ON EACH ACTIVITY EVALUATED)

1. INDUSTRIAL ACTIVITY TITLE	2. INDUSTRY CODE NO.	3. INVENTORY REPORT REFERENCE PAGE _____ LINE _____

4. NO. OF INSTALLATIONS	5. LOCATION OF INSTALLATIONS

6. COMPONENT ACTIVITIES

7. EXPENDITURE FISCAL YEAR 1954 $ _____	8. EXPENDITURE FISCAL YEAR 1955 $ _____

9. NO. EMPLOYEES JUNE 30, 1954: CIVILIAN _____ MILITARY _____	10. EXPLAIN ANY SPECIAL SEASONAL ACTIVITY PEAK EMPLOYMENT: CIVILIAN _____ MILITARY _____

11. DISPOSITION OF PRODUCT FISCAL YEAR 1954: GOVERNMENT USE _____% DISTRIBUTED TO PUBLIC FREE _____% SOLD TO PUBLIC _____%

12. VALUE OF CAPITAL ASSETS: LAND $_____ BUILDINGS $_____ EQUIPMENT $ _____

13. LEGAL AUTHORIZATION: REQUIRED ☐ SPECIFICALLY AUTHORIZED ☐ CONGRESSIONAL APPROVAL (EXPLAIN) ☐ GENERAL AUTHORIZATION ☐ OTHER (EXPLAIN) ☐

U. S. CODE REFERENCE OR EXPLANATION

14. AGENCY DETERMINATION: ELIMINATE ☐ CURTAIL ☐ CONTINUE ☐ OTHER (EXPLAIN) ☐

SECTION B (TO BE COMPLETED ON ALL ACTIVITIES ON WHICH NO. 14 IS NOT CHECKED "CONTINUE")

15. SPECIFIC ACTION

16. EFFECTIVE DATE OF ACTION _____

17. STATUS OF ACTION

18. EXPLAIN ANY LEGISLATION NEEDED TO EFFECT ACTION

19. DISPOSITION OF ASSETS

20. AMOUNT RECOVERED $ _____

21. VALUE OF ASSETS RETAINED $ _____

22. EFFECT OF ANNUAL EXPENDITURES

$ _____ LESS WILL BE SPENT

_____ WILL BE SPENT IN A DIFFERENT MANNER (AS PAYMENTS TO VENDORS OR CONTRACTORS RATHER THAN FOR PERSONNEL AND FACILITIES)

_____ MORE WILL BE SPENT

_____ OTHER (EXPLAIN)

23. REDUCTION IN NUMBER OF PERSONNEL

_____ CIVILIAN
_____ MILITARY } FEWER EMPLOYEES WILL BE NEEDED

_____ OTHER (EXPLAIN)

SECTION C (TO BE COMPLETED FOR ALL ACTIVITIES ON WHICH NO. 14 IS CHECKED "CONTINUE")

24. REASON FOR DECISION TO CONTINUE AS GOVERNMENT OPERATION (IF MORE SPACE IS NEEDED ATTACH A SEPARATE SHEET).

25. IF UNAVAILABILITY OF PRODUCT OR SERVICE COMMERCIALLY IS REASON GIVEN IN NO. 24, EXPLAIN

26. IF COST IS REASON GIVEN IN NO. 24, IDENTIFY ITEMS CONSIDERED IN COST COMPUTATIONS AND SOURCE OF COMMERCIAL COSTS USED IN COMPARISONS.

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D.C., February 5, 1957.

Bulletin No. 57–7.

To: The Heads of executive departments and establishments.

Subject: Commercial-industrial activities of the Government providing products or services for governmental use.

1. *Purpose.*—Bureau of the Budget Bulletin No. 55–4 of January 15, 1955, established policy and initiated a review of commercial-industrial-type activities conducted by the Government that provide services or products for its own use which can be procured from private enterprise through ordinary business channels (referred to as "commercial activities"). This bulletin gives further instructions with respect to (*a*) the evaluation of commercial activities classified as services, (*b*) the termination of commercial activities, and (*c*) the starting of new commercial activities.

GENERAL POLICY AND ITS INTERPRETATION

2. *Policy.*—It is the general policy of the administration that the Federal Government will not start or carry on any commercial activity to provide a service or product for its own use if such product or service can be procured from private enterprise through ordinary business channels. Exceptions to this policy shall be made by the head of an agency only where it is clearly demonstrated in each case that it is not in the public interest to procure such product or service from private enterprise.

3. *Meaning of certain terms.*—The following interpretations apply to the preceding paragraph:

(*a*) In determining whether an activity is "commercial" in nature and "can be procured * * * through ordinary business channels," reference may be made to the "Standard Industrial Classification Manual," to the availability of the service or product on a competitive basis, and to ordinary business practice with respect to procurement thereof. The inclusion of an activity in the manual will be generally considered indicative that it may be procured through ordinary business channels. There will be excluded as noncommercial, however, those functions which are a part of the normal management responsibilities of a Government agency or a private business of comparable size (such as accounting, personnel work, and the like). Information as to both source and ability of private enterprise to provide a product or service may be secured from the Business and Defense Services Administration of the Department of Commerce.

(*b*) "Activities * * * for its own use" includes the activities of producing a service or product *primarily* for the use of the Government (whether the same agency or other agencies), even though some portion of the product or service is sold or given to the public. It includes activities which are to provide a service or product for the use of a Government agency in its official duties, even though the agency is engaged in carrying out a service to the public (e.g., the manufacture of mailbags or the generation of power at a Government institution). However, it excludes the activities of producing a service or product primarily to be sold or given to the public (e.g., the generation of power for sale to the public) and those primarily for the employees (e.g., the provision of quarters for rent to employees at remote locations).

The fact that this bulletin does not deal with products or services provided directly to the public in no way relieves the agencies of keeping such activities under constant review and reevaluation as to the need for the Government to carry on such activities.

(*c*) "Start" means to begin any activity of a commercial nature in a location where it was not previously carried on by an agency within the preceding 12 months.

4. *Costs and prices.*—The relative costs of Government operation compared to purchase from private sources will be a factor in determining whether to start or carry on a commercial activity in those cases where the agency head concludes that the product or service cannot be purchased on a competitive basis and cannot be obtained at reasonable prices from private industry.

Prices may be considered reasonable when the price to the Government is not greater than the lowest price obtained by other purchasers, taking into consideration volume of purchases and quality of the products or services.

In those cases where the product or service cannot be purchased on a competitive basis nor at a reasonable price on a noncompetitive basis, it may be necessary to make a comparison of prices with costs of Government operation. In doing so, the costs of Government operation should be fairly computed and complete, covering both direct and indirect costs, including elements not usually chargeable to current appropriations, such as depreciation, interest on the Government's investment, the cost of self-insurance (even though it is unfunded); there shall also be added an allowance for Federal, State, and local taxes to the extent necessary to put the costs on a comparable basis. Care must also be exercised to see that the costs of procuring material from private sources are fairly computed and complete. They should be truly representative of the lowest price the Government would pay for the quantity and quality needed, taking into account all applicable indirect costs of the Government for such procurement.

EVALUATION OF SERVICES

5. *Scope of evaluation.*—Each agency shall make an evaluation of all its commercial activities which are classified as "services" in volume II of the "Standard Industrial Classification Manual," division I, group Nos. 70–89, inclusive. Reports shall be made thereon with the following exceptions:

(*a*) There may be excluded activities which are outside the continental United States and the Territories of Alaska and Hawaii.

(*b*) Any activity at any one location which involves an equipment investment of less than $5,000 and a product or service with an approximate annual value of less than $25,000 shall be excluded.

(*c*) Government-owned, contractor-operated facilities may be excluded.

Evaluation reports should include all service activities previously reported in agencies' inventories and other such activities as were subsequently established or were not previously reported.

6. *Purpose of evaluation.*—In making the evalution the agency will (*a*) determine whether or not each of these service activities should be continued in the light of the policies set forth in sections 2 to 4 above, (*b*) determine whether statutory changes are necessary to permit discontinuance, and (*c*) take appropriate steps to discontinue activities on the basis of the evaluation. In any case where it is determined to continue an activity, it should be curtailed in scope and volume to the extent practicable.

7. *Reports on evaluation.*—Three copies of the evalution reports—exhibit 57–7A (copy attached)—shall be submitted to the Bureau of the Budget on or before April 15, 1957. Up to 60 copies of this report form may be secured from the Bureau of the Budget Publications Unit, code 146, extension 616; if more copies are needed, the agencies should have them reproduced.

8. *Applicability to the Department of Defense.*—A special time schedule is being established for the evaluation of service activities in the Department of Defense.

TERMINATING COMMERCIAL ACTIVITIES

9. *Prompt and orderly action.*—Except where statutory change is necessary to permit discontinuance of an activity, the agencies shall discontinue or curtail each commercial activity as soon as the agency head determines that it is reasonably possible to do so. Each agency shall exercise diligence in carrying out such actions in an orderly way and shall proceed on a reasonable time schedule. Adequate notice shall be given to the community and employees in advance of discontinuance or curtailment, and each agency shall assist employees as necessary in finding other employment. Where statutory change would be necessary to permit discontinuance, the agency head shall seek such changes promptly, submitting drafts of legislation or appropriation language, as may be required, to the Bureau of the Budget in the usual manner.

10. *Steps to be taken before establishing new activities.*—No new commercial activity shall be started until, as a minimum, the head of the agency has—

(*a*) Ascertained that the product or service is necessary to the conduct of a governmental function.

(*b*) Provided a reasonable opportunity for private enterprise to indicate its ability to furnish the product or service.

(*c*) Determined, on the basis of the response from private enterprise, that the product or service cannot be supplied on a competitive basis or at reasonable price through ordinary business channels.

(*d*) Determined that it is not in the public interest to procure the product or service from private enterprise, either because it is not available on a competitive basis or at a reasonable price (as found under step (*c*) above), or because of overriding considerations of law, national security, or national policy.

(*e*) Made an adequate record that the foregoing steps have been taken.

Steps (*b*) and (*c*) may be omitted in those cases where overriding considerations of law, national security, or national policy require that the activity be conducted as a Government operation, but in such cases the head of the agency shall make an appropriate record of his findings and conclusions to that effect.

11. *Reports on new starts.*—Each agency will make a report to the Bureau of the Budget by April 1, 1957, setting forth the following information with respect to each new activity approved for starting during the period from its previous inventory report to December 31, 1956, unless it involves an equipment investment of loss than $5,000 and a product or service with an approximate value of less than $25,000.

(*a*) Type of activity. Use the classification code number and title set forth in the Standard Industrial Classification Manual, and add such descriptive words as are needed to indicate exactly the activity being reported.

(*b*) Location.

(*c*) Purpose.

(*d*) Volume of capital assets on hand and on order as of December 31, 1956.

(*e*) Average current (December 31, 1956) number of employees and average number contemplated when activity is in full operation.

(*f*) Reasons requiring the establishment or expansion of the activity.

(*g*) Date of determination.

Agencies should keep appropriate records centrally in order that they may prepare similar reports in the future as may be required.

By direction of the President:

PERCIVAL F. BRUNDAGE, *Director.*

ATTACHMENT A TO BUREAU OF THE BUDGET BULLETIN NO. 57–7

INSTRUCTIONS FOR EVALUATION REPORT ON SERVICE ACTIVITIES

Section A: This section is to be filled out on all service activities. Answer only those questions which are applicable.

1. Use the industrial title from the Standard Industrial Classification Manual which describes the activity at the highest organization level that can be analyzed as a separate commercial activity, even though it may have a number of commercial activities as components.

2. Use the code number corresponding to the title from the Standard Industrial Classification Manual.

3. Refer to the proper page and line of the agency's inventory report previously submitted. If the activity was subsequently established, or had not previously been reported in the inventory, it should be indicated.

4. This should be the number of similar installations. Exclude those reported elsewhere as a part of another major activity.

5. If there are relatively few such installations, give their location. If there is a larger number of such installations, use some descriptive term, such as "at all dam construction sites" or "one in each seaboard State."

6. Show as subordinate activities the types listed in the Standard Industrial Classification Manual which form a part of the major activity listed in No. 1.

7. This should be an estimate of the total expenditures attributable to the activity for the fiscal year 1956.

8. This should be an estimate of the total expenditures attributable to the activity for the fiscal year 1957.

9. Show the number of employees assigned to the activity who were included on the Standard Form 113 report to the Civil Service Commission and the number of military personnel assigned to the activity.

10. If the number of employees shown in No. 9 is not representative of the normal or seasonal size of the operation, explain the seasonal character and give figures which reflect the maximum employment during the peak season.

11. On a percentage basis, account for the disposition made during fiscal year 1956 of the service.

12. The value of land and buildings should be the same (initial cost) as reported to the General Services Administration in connection with its survey of real property holdings. For assets, if any, which are not included in the GSA survey, use the same concept of initial cost, or the best estimate thereof, in setting the asset figure. This concept should also govern the value placed on equipment which was not covered by the GSA survey.

13. Check the block which indicates the authority and circumstances under which the activity is conducted. If it is required by law check "Required." If it is specifically authorized but not required by law, check "Specifically authorized." If it is not specifically authorized or required but has been the subject of specific congressional approval in appropriation acts or some other legislation, check "Congressional approval" and explain the circumstances. If there is no specific approval, but the agency considers that its basic legislation authorizes the activity, check "General authorization." Use the "Other" block only if none of the previously mentioned categories is applicable, and explain the circumstances. Wherever there is legislation under which the activity is authorized, give the United States Code citation.

14. Indicate by a check what the agency head determines is to be done about the continuation of the activity. Check the block "Eliminate" if the Government operation is to be closed and the facilities disposed of. Check "Curtail" if the volume of activity is being reduced but the activity will continue as a Government operation. "Continue" will be used to denote the decision by the agency head that it is not in the public interest to procure the product or service from private enterprise. Check "Other" if the activity is being converted to a contractor-operated basis or some combination of ways of procuring the product. If the "Other" block is checked, give a brief explanation of what is to be done.

Section B. This section should be completed for all activities on which No. 14 is not checked "Continue."

15. State exactly what is to be done.

16. Show the date on which the activity has been or will be eliminated, curtailed, or otherwise modified.

17. If the agency head's determination is not yet in effect, indicate the extent to which negotiations or other actions have progressed on the date of the report.

18. If the agency head's determination cannot be carried out because of existing law, summarize any legislative proposals being submitted to the Bureau of the Budget.

19. If the assets which were used in the conduct of the activity are to be sold or otherwise disposed of, so indicate. If they are not to be disposed of, give reasons.

20. If any of the assets have been disposed of, show the amount recovered from their sale. If they have not been but will be later, indicate an estimated amount to be recovered, adding "estimate."

21. Use the same basis for determining the value of the assets being retained as was used in estimating the value of the capital assets in No. 12.

22. There will normally be an entry on line 2 and in addition there may be one on lines 1 or 3, depending on the action being taken. The first line should show savings. The second should show amounts formerly spent for Government operations which hereafter will be spent for procurement of the product by direct purchase or contractual arrangements. The third line should show any increase in out-of-pocket costs of procuring the product, whether or not additional appropriations will be requested. The last line will be used for any other circumstances which will prevail. These need not be exact figures developed by a cost study but may be estimated amounts.

23. The changes in the numbers of persons engaged in the activity will be related to the answer on No. 9. The number eliminated does not necessarily mean that employment of the particular individuals will be terminated but it does mean that the personnel requirements of the agency will be reduced to that extent so far as the activity is concerned.

Section C: This section is to be completed whenever the agency head decides that the activity is to be continued as a direct Government operation.

24. This justification must be complete, showing the reasons why the agency head has decided that there is a clear demonstration that it is not in the public interest to procure such service from private enterprise.

25. If unavailability of the service commercially is a reason given in No. 24, this item will be used to indicate the circumstances under which the service is provided by private enterprise under normal business conditions. It should also indicate whether the geographical location of the activity is such that private enterprise is not in a position to fill the agency's needs. This should be answered only after specific analysis of the problem and must include a description of the steps which the agency has taken to be sure that private industry either can or cannot furnish the agency's needs.

26. If relative costs have been computed in accordance with the conditions set forth in section 4 of the bulletin, the answer in No. 24 should explain the method of determining that the product or service cannot be purchased at a reasonable price on a competitive basis, and this item (No. 26) will be used to make a comparison of prices with costs of Government operation. This statement should show both the results of the comparative cost analysis and the elements which have been used in determining the Government cost, both as a direct operation and if the service is secured from private industry.

EXHIBIT 57-7A

EVALUATION REPORT UNDER BUREAU OF THE BUDGET BULLETIN NO.
ON GOVERNMENT OPERATED SERVICES ACTIVITIES

(AGENCY) (BUREAU) (DATE)

ADDITIONAL INFORMATION WILL BE SUPPLIED BY SUBMITTED BY: (SIGN) _____

NAME _____

TITLE _____ TEL. NO. _____

SECTION A (TO BE COMPLETED ON EACH ACTIVITY EVALUATED)

1. INDUSTRIAL ACTIVITY TITLE | 2. INDUSTRY CODE NO. | 3. INVENTORY REPORT REFERENCE PAGE ____ LINE ____

4. NO. OF INSTALLATIONS | 5. LOCATION OF INSTALLATIONS

6. COMPONENT ACTIVITIES

7. EXPENDITURE FISCAL YEAR 1956 $ _____ | 8. EXPENDITURE FISCAL YEAR 1957 $ _____

9. NO. EMPLOYEES JUNE 30, 1956:
CIVILIAN _____
MILITARY _____

10. EXPLAIN ANY SPECIAL SEASONAL ACTIVITY
PEAK EMPLOYMENT: CIVILIAN _____ MILITARY _____

11. DISPOSITION OF SERVICE FISCAL YEAR 1956: GOVERNMENT USE _____ % DISTRIBUTED TO PUBLIC FREE _____ % SOLD TO PUBLIC _____ %

12. VALUE OF CAPITAL ASSETS: LAND $_____ BUILDINGS $_____ EQUIPMENT $_____

13. LEGAL AUTHORIZATION: REQUIRED ☐ SPECIFICALLY AUTHORIZED ☐ CONGRESSIONAL APPROVAL (EXPLAIN) ☐ GENERAL AUTHORIZATION ☐ OTHER (EXPLAIN) ☐
U. S. CODE REFERENCE OR EXPLANATION

14. AGENCY DETERMINATION: ELIMINATE ☐ CURTAIL ☐ CONTINUE ☐ OTHER (EXPLAIN) ☐

SECTION B (TO BE COMPLETED ON ALL ACTIVITIES ON WHICH NO. 14 IS NOT CHECKED "CONTINUE")

15. SPECIFIC ACTION

16. EFFECTIVE DATE OF ACTION _____

17. STATUS OF ACTION

18. EXPLAIN ANY LEGISLATION NEEDED TO EFFECT ACTION

19. DISPOSITION OF ASSETS

20. AMOUNT RECOVERED $_____

21. VALUE OF ASSETS RETAINED $_____

22. EFFECT ON ANNUAL EXPENDITURES

$ _____ LESS WILL BE SPENT

_____ WILL BE SPENT IN A DIFFERENT MANNER (AS PAYMENTS TO VENDORS OR CONTRACTORS RATHER THAN FOR PERSONNEL AND FACILITIES)

_____ MORE WILL BE SPENT

_____ OTHER (EXPLAIN)

23. REDUCTION IN NUMBER OF PERSONNEL

_____ CIVILIAN
_____ MILITARY } FEWER EMPLOYEES WILL BE NEEDED

_____ OTHER (EXPLAIN)

SECTION C (TO BE COMPLETED FOR ALL ACTIVITIES ON WHICH NO. 14 IS CHECKED "CONTINUE")

24. REASON FOR DECISION TO CONTINUE AS GOVERNMENT OPERATION (IF MORE SPACE IS NEEDED ATTACH A SEPARATE SHEET).

25. IF UNAVAILABILITY OF SERVICE COMMERCIALLY IS REASON GIVEN IN NO. 24, EXPLAIN.

26. IF COST IS A FACTOR GIVEN IN NO. 24, IDENTIFY ITEMS CONSIDERED IN COST COMPUTATIONS AND SOURCE OF COMMERCIAL PRICES USED IN COMPARISONS.

U.S. ATOMIC ENERGY COMMISSION,
Washington, D.C., March 4, 1957.

Memorandum to: Directors of Washington Divisions and Offices; Managers of Operations Offices.
From: R. W. Cook, Deputy General Manager.
Subject: Policies on Commercial-Industrial Activities of the Government.
Symbol: FAc:JJN.

You will recall that on January 15, 1955, the Bureau of the Budget issued Bulletin 55–4, which required a review of all commercial-industrial activities of the AEC and its contractors. Additional instructions have recently been issued as Bulletin 57–7, copies of which were furnished you by the Comptroller. Your attention is called specifically to paragraphs 2, 3, 4, 9, and 10 of the bulletin, which set forth basic policies to be followed in terminating commercial activities or in startng new activities.

You are requested to review your activities in the light of this bulletin and submit appropriate recommendations, if any existing or planned activities are in conflict with the bulletin.

U.S. GOVERNMENT,
October 17, 1958.

Office memorandum to: All Managers as listed below.
From: S. H. Sapirie, Manager, Oak Ridge Operations.
Subject: Commercial Processing and Fabrication Services.
Symbol: OPO:EOR.

The latest interpretation of the General Manager's policy of utilizing commercial facilities to the greatest extent practical indicates that all AEC requirements for materials and/or services for use in activities under programs other than 2000 and 3000 should be considered for commercial procurement. One criterion which should weigh strongly in the decision as to utilization of commercial procurement is whether or not a requirement can be satisfied completely by merely diverting materials and services already routinely utilized in the 2000 and 3000 programs without further work and without adversely affecting those programs. Below is a list of the materials which may be considered routinely available from 2000 and 3000 programs in Oak Ridge. We hope such information will be of value to you in determining proper procurement channels.

Enriched uranium:

UF_6.
UF_4 (highly enriched).
Metal (as-reduced buttons, highly enriched).

Normal uranium:

UF_6.
UO_3.
UF_4.
Metal.
Derbies, Dingots and Ingots.
Oval rods, $2\frac{9}{16}$ inches by $2\frac{3}{32}$ inches by lengths up to 17 feet.
Oval rods, $1\frac{5}{16}$ inches by $1\frac{15}{16}$ inches by lengths up to 21 feet.
Round rods, 1.4 inches diameter by lengths up to 22 feet.
Round rods, 1.1 inches diameter by lengths up to 22 feet.
Slugs (hollow cylinders), 8.3 inches long by 1.4 inches O.D. by 0.4 inches I.D.
Slugs (hollow cylinders), 8.1 inches long by 1.1 inches O.D. by 0.6 inches I.D.

Depleted uranium:

UF_6.
UF_4 (U^{235} content as used in production activities at time of request).
Metal (U^{235} content as used in production activities at time of request. Available in as-reduced form).

Until instructed to do otherwise, Oak Ridge will honor all requests from other AEC offices for source and/or special nuclear materials or for processing or fabrication of such materials, under the assumption that compliance with Commission policy in transactions of this nature is the responsibility of the requestor. However, Oak Ridge Operations Office is required to report to the Division of Production, Washington, any request which seems appropriate for commercial procurement when there is no indication that such action has been considered.

It is desired that future requests include a statement as to whether or not the use of industrial facilities has been explored.

Your cooperation in this matter will be greatly appreciated.

S. R. SAPIRIE.

Addresses:
K. F. Hertford, manager, Albuquerque operations.
Kenneth A. Dunbar, manager, Chicago operations.
Allan E. Jones, manager, Grand Junction operations.
James E. Travis, manager, Hanford operations.
Allan C. Johnson, manager, Idaho operations.
H. H. Gorman, manager, Lockheed Aircraft reactors operations.
Merril Eisenbud, manager, New York operations.
L. D. Geiger, manager, Pittsburgh Naval reactors operations.
Harold A. Fidler, manager, San Francisco operations.
R. C. Blair, manager, Savannah River operations.
J. D. Anderson, manager, Schenectady naval reactors operations.

CC: R. C. Armstrong.
H. M. Roth.
J. W. Ruch.

U.S. GOVERNMENT,
November 4, 1959.

To: Joseph C. Clarke, Manager, New York Operations Office.
From: Frank K. Pittman, Director for Division of Reactor Development, Washington.
Subject: Central Commercial Recovery of Uranium Scrap.
Symbol: RD:CA:RWZ.

You are hereby directed to develop the commercial recovery of unirradiated uranium scrap generated in the course of Reactor Development Civilian, Army, Navy, Aircraft, and Maritime program activities. You will act as a central point for the Commission in collecting information upon the availability of scrap, placement and administration of contracts for recovery of scrap, and related sampling and analytical services. In carrying out this task you are to apply the following standards:

1. Scrap accumulating at reactor development contractors is to be reprocessed reasonably promptly both to prevent any delay in contractor work because of excessive amounts of fissionable material on site, and to reduce the economic loss of capital charges on uranium tied up as scrap.

2. Scrap may be recovered either at Oak Ridge or via commercial reprocessors, keeping in mind that wherever feasible, in terms of schedules, ability to recover unusual scrap combinations, and price, scrap should be sent to commercial reprocessors. Of course, if a given batch of scrap appears uneconomical to recover, you may recommend to the originating office that they dispose of it as waste.

I have requested other operations offices to cooperate with you, particularly in providing information about present and future scrap generation, and in sending scrap to Oak Ridge or to commercial reprocessors. The cost of the commercial reprocessing orders is to be billed to the operations office responsible for the scrap. You are to budget for NYOO scrap and also for sampling and analytical services required for all scrap reprocessing.

Enclosure:
Copy memo Pittman to those listed below (COO, SNROO, PNROO).

U.S. GOVERNMENT,
December 4, 1959.

Office memorandum
To: Assistant Directors and Manager of Operations Offices.
From: Frank K. Pittman, Director, Division of Reactor Development.
Subject: Guidelines for Preparation of Announcements on DRD Invitations for Contract Proposals.
Symbol: RD:ADM:RS:EEH.

The following guidelines are furnished with regard to the preparation of announcements regarding this Division's invitations for unclassified bids, proposals, award of contracts, etc.:

It is policy of this Division to secure the broadest possible base of competition among those companies and organizations qualified to perform research and

development work required in our program. Organizations not included in invitation lists will be added to such lists provided they can demonstrate technical competence and satisfactory experience in the field.

Accordingly, all invitations for proposals which are to be on an open, competitive basis, are to be publicly announced at the time of the invitation. Such announcements will be local unless they involve large projects or new work of national interest which will be jointly announced by headquarters and the operations office.

By the same token, public announcement will not be made on invitations for research and development proposals where the nature of the work requires the preselection of proposers determined to be technically qualified and otherwise competent in the particular field.

Invitation for fixed-price, competitive procurement, to be awarded on the basis of low bid, will be announced at the time bids are requested and the names of all bidders may be announced immediately following the public opening of the bids.

In all other situations where evaluation of proposals by a contract board or similar negotiations and discussions precede the selection, neither the number of proposals received nor the names of those submitting proposals will be announced prior to announcement of the selection or award of the contract. If the selection is announced before agreement on contract terms is reached, the names of other proposers shall not be released until the contract has been completed although direct notice to the unsuccessful proposers may be given.

U.S. GOVERNMENT,
February 12, 1960.

Office memorandum.
To: Operating divisions, managers of operations.
From: A. R. Luedecke, General Manager.
Subject: Budget Bureau Bulletin 60–2.

There are being transmitted to you copies of the Commission reply [1] to letters received from three national associations which cited examples of goods and services which they indicated might be procured from private industry through ordinary business channels under the criteria of Budget Bureau Bulletin 60–2.

The policy and principles set forth in the Commission's letter should serve as further guidance to your office and to the operating contractors under your jurisdiction for the application of the provisions of Budget Bureau Bulletin 60–2 to your activities. Periodically, you will be requested to submit information on specific programs and activities to this office which will keep us better informed as to progress made in implementing this Budget Bureau Bulletin 60–2 and the policy guidance contained in the attached Commission letter.

In the appendix to the letter which provides answers to the examples cited, you will note that in some cases procurement of goods and services from private industry could be made more uniform, particularly as industry capability grows. In these cases you are requested to follow up with the contractors concerned for any necessary strengthening of procedures.

Obviously, in future implementation of this policy as in the past, the decision to procure a material or service from a commercial industrial source rather than from a Government-owned plant should be done only when it is reasonable under our policy to do so. Reasonableness should include consideration of whether and to what extent the particular case is part of AEC's effort to develop and establish, on a time scale commensurate with achievement of economically competitive nuclear power, private capability to supply materials and services of those kinds which will ultimately be required in the private field; and whether the price of the material or service, if higher than AEC cost, is justified to encourage the developing industry. Where competitive bids are available, Federal policy on commercial procurement is clear.

In the continuing review of activities for the determination of the feasibility of procurement from private enterprise, there may arise questions of the degree of the continued performance of such activities in Commission facilities in view of the programatic responsibilities of the Commission, the character of the capability of industry, the inherent difficulties of performance, the effect of outside procurement on the integration of operations, the size of cost differentials, or related matters. Any such questions on particular cases should be referred to the operating division director for appropirate staff review and guidance.

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[1] CLERK NOTE.—See p. 81 for Commission letter.

Mr. JENSEN. Of course, the reason I asked this question was to give you an opportunity to clear up some of the talk we have heard which has not come out too much in the open. But I am sure that you favor private enterprise as against Government ownership when private enterprise can do the job as well or better.

Does the AEC supervise the decisions made at Government-owned installations to do commercial industrial work? Has the Commission given any thinght to a method of supervising the carrying out of its policy to insure its uniform and proper implementation? Do you want to comment on that?

Mr. MCCONE. Yes. I think through our division offices we are constantly in contact with our laboratories which are Government-owned and contractor-operated to see that they make the maximum use of private industry.

I would like to point out, however, that there is a wide difference of opinion among spokesmen for private industry as to just what does represent private industry, let us say. There are those who come to us and say, "Now, we would like to do this piece of work for you. You give us the money to build a plant and you give us a contract guarantee for the full operation of the plant, and then we will go right ahead."

Mr. CANNON. And protection against any damage which might be incurred.

Mr. MCCONE. That is right. This I don't think is representative of private industry, as I know private industry. There are those who say, "Don't put project A in X laboratory. Turn it over to a laboratory operated by company B, which we don't have, but give us the money to build that laboratory." That I don't think represents private industry. But where we can procure goods and services from private industry, that is what we do.

Incidentally, this discussion has not been so quiet, Mr. Jensen. I have had innumerable meetings with representatives of industrial groups and at the conclusion of the meeting I felt that they were satisfied that the Atomic Energy Commission is following a reasonable policy with reference to private industry.

Mr. JENSEN. I suppose you also told them after the meeting was over that you did not blame them for trying? You know, that is one thing about we Americans——

Mr. MCCONE. Off the record.

(Discussion off the record.)

Mr. JENSEN. That is one of the great attributes of the American people. You know, our Constitution says in effect, "Now, Mr. American, you look after yourself first. You are bound to obey the laws, and you do what you think is best for yourself and your family. You have a sovereign government after you are married. You are the king, your wife the queen." We have now something like 47 million sovereign governments in American homes and they look after themselves first, and therein lies the strength of this great Republic of ours.

There are selfish people naturally. I have never held it against a person to better himself. I will say, "You can't do this, but I don't blame you for trying." So I never hold it against anybody for trying, as long as they stay within the purview of certain rules and regulations that we adhere to pretty religiously in this country of ours.

What is meant by the recurring phrase in your February 10 response, "Industry was not interested"? How was this determined? Were specifics released and bids called for in all cases?

Mr. McCone. I can give you an example. Several years ago we attempted to interest private industry in the chemical processing of fuel. We made available the technology and know-how and various groups examined the prospects and they were not interested for the simple reason that the volume of business obtainable was not sufficient to warrant the investment in the plant, properly amortized.

Mr. Jensen. At that time.

Mr. McCone. At that time. Now, more recently there has been interest expressed by a group, and we are working very closely with them, giving them all information, including classified information, so they can make their new evaluations to determine whether this represents an area of sufficient business interest, business opportunity, so that they can make the necessary investment. As I said in my prepared statement, in view of this investigation, we are not going forward with modifications to our plants which have been previously authorized by your committee, Mr. Chairman, because if industry can come along and do this job that will be fine. We would like to see Government get out of that business. There are innumerable examples where economic and commercial outlook is not sufficient to warrant industry's participation.

Mr. Jensen. We all know this is an enterprise in which Government and private industry must cooperate to get the best job done. I can readily understand this problem, Mr. McCone. You have a most difficult task, you and your fine staff, but I have nothing but praise for you. I ask these questions because I want to give you an opportunity to explain it before the committee.

Now, in connection with the questions I have asked Mr. McCone, I ask unanimous consent that copies of the various correspondence between industry groups mentioned and AEC and the Joint Committee on Atomic Energy be inserted in the record at this point.

Mr. Cannon. Without objection, it may be included.

(The information referred to follows:)

National Association of Manufacturers
of the United States of America.
New York, N.Y., December 4, 1959.

Mr. John A. McCone,
Chairman, Atomic Energy Commission, Washington, D.C.

Dear Mr. McCone: A special task force of our nuclear energy committee has reviewed in considerable detail activities in the nuclear energy field as they might come within the scope of Bureau of the Budget Bulletin 60–2. This letter outlines the results of the initial deliberations of that group.

The Atomic Energy Act of 1954 states in chapter 1, section 1b that, among other objectives, it shall be the policy of the United States to use atomic energy to "strengthen free competition in private enterprise." We believe that Congress intended that the full strength of the private enterprise system be brought to bear on the development of a healthy, competitive nuclear industry. Your stated policy as Chairman of the AEC has reemphasized that point on numerous occasions.

We recognize that the situation existing today is considerably different from that which existed at the time of the passage of the 1954 act. At that time, indusry was just entering the nuclear field and needed technical assistance from the AEC. Today, industrial capability has greatly increased and there are a number of areas in which the AEC is operating programs in Government-owned facilities which are in direct competition with industry.

It is our fundamental belief that in the area of civilian programs, Government-owned facilities should be used only for research and development activities requiring special facilities which do not exist in industry. However, insofar as possible, activities should be carried on by privately owned facilities, financed with private funds.

From this fundamental viewpoint, the special task force outlines below several areas of specific competition:

A. Fuel cycle

(1) There is a substantial existing private industry to process uranium from the mine to fabricated reactor cores with the exception of the uranium 235 enrichment process. Everywhere that the Government operates in its own facilities in this area, with the noted exception, there is direct competition with industry.

(*a*) Conversion from UF_6 and fabrication of fuel elements for AEC nuclear rocket program at Livermore; for subcritical training reactors; for heavy water components test reactor, Savannah River; for process heat reactor to be built at Point Lomas, Calif.

(*b*) Supply of enriched uranium oxide, pellets, or metal for gas-cooled reactor project; ETR and MTR at Arco, Idaho; NPR at Hanford; and all uranium alloys or compounds for the "Nuclear Navy."

(2) Government-owned laboratories are fabricating depleted uranium into shielding casks and other forms for reactor projects. Private industrial capability exists for such operations.

For example:

(*a*) Supply of blanket fuel elements for zero power reactor at Argonne National Laboratory.

(*b*) Conversion from UF_6 of depleted uranium required for shielding cask at Bettis Field.

(*c*) Supply of depleted metal for shielding cask project at Schenectady.

(3) In the area of reprocessing of irradiated fuel elements, the Government can and should greatly aid in the transition to a commercial mode of operation by making maximum use of industrial groups in process research and development and in construction of, and operations related to, reprocessing plants. To promote the growth of a healthy industry in this area, Government funds should be used to finance research and development programs in privately owned facilities in preference to Government owned facilities.

B. Irradiation services

The AEC should announce a policy to utilize privately owned reactors for materials testing to the extent that industry is able to provide space. This use of private reactors should be in preference to the use of a similar Government owned facility. The current use of MTR and ETR for Government sponsored research, which constitutes the great majority of the materials testing business, results in severe competition for the private test reactors.

C. Supply of other materials and services

(1) There are industrial facilities available with the capacity to furnish practically all special materials and services; these should be used in preference to Government owned facilities.

For example:

(*a*) Supply of thorium oxide for homogeneous reactor development at ORNL.

(*b*) Supply of thorium metal for special projects at Los Alamos, Sandia, Lawrence Radiation Laboratory at Livermore.

(*c*) Supply of high purity cobalt for High Intensity Radiation Development Laboratory, Brookhaven.

(*d*) Design, construction, and testing of reactors, reactor prototypes, and reactor experiments for which industrial capacity and capital exists.

(*e*) The first reactor in the Army low-power reactor program was fabricated by an industrial concern at its own facilities, but the second will be fabricated in a Government-owned facility.

(*f*) Furnishing of film badge service for personnel monitoring. Although a number of industrial firms offer this service, competing services are performed at Oak Ridge, Brookhaven, Savannah River, Sandia, etc.

(*g*) Personnel radiation monitors are developed and produced in instrument production sections at Government-owned laboratories. There is an

instrument industry capable of furnishing such monitors and it should be used.

(*h*) Government construction of radiation measuring equipment is also in direct competition with the private instrument industry.

To reiterate my opening comment, programs in the nuclear field should be carried out in privately owned facilities wherever possible. Government-owned facilities should be used only for research and development projects for which equipment is not available in industry.

We trust these comments will be of value in connection with your consideration of Bureau of the Budget Bulletin 60–2. As time goes on, there may be other instances of similar activities which come to our attention and we should welcome the opportunity to discuss them with you as the occasion arises.

Sincerely yours,

J. F. FAIRMAN,
Chairman, Nuclear Energy Committee.

ATOMIC ENERGY COMMISSION,
Washington, D.C., December 29, 1959.

Mr. JAMES F. FAIRMAN,
Chairman, Nuclear Energy Committee,
National Association of Manufacturers,
New York, N.Y.

DEAR MR. FAIRMAN: Since receiving your letter of December 4, 1959, and similar requests from two other organizations, we have undertaken a review of the projects listed in your letter. To assist us in arriving at reasonable conclusions on an expeditious schedule, we need certain information from you.

For each of the products and services you mention we need specific data on industry's existing facilities and capacity by company to handle the work.

We would like to have these data available by January 25, 1960, to coincide with our collection of data from the organizations requiring the material or service.

Sincerely yours,

A. R. LUEDECKE,
General Manager.

NATIONAL ASSOCIATION OF MANUFACTURERS
OF THE UNITED STATES OF AMERICA,
New York, N.Y., January 15, 1960.

Maj. Gen. A. R. LUEDECKE,
General Manager, Atomic Energy Commission,
Washington, D.C.

DEAR GENERAL LUEDECKE: This is in reply to your letter of December 29, 1959, requesting specific data on industrial facilities and capacities to carry out various projects outlined in my earlier letter.

We fully understand your need for specific information and we wish to cooperate as fully as possible. As I mentioned in my letter, we, and you, are interested in the development of a healthy, competitive nuclear industry. In the areas outlined in the letter, members of the NAM nuclear energy committee indicated that the functions could be performed by private industry, but we are not certain, by any means, that they represent the entire industrial potential.

For us, as representatives of a large and variegated association, to gather the data in anything like a comprehensive form would require a survey of considerable magnitude, which the time schedule specified in your letter would not permit. In our opinion, to furnish you with a hastily prepared list of companies and

capacities would, in the long run, be detrimental to the long-term objectives of both of our groups.

On the other hand, you mention that you are collecting data from your facilities which require materials or services. If you could make such data available to us, we would be glad to find out from our members what projects they are capable of undertaking.

There is still another and perhaps better approach which should serve to furnish you with the type of information you seek. For a given project, within the general areas outlined in my letter, the AEC could solicit proposals from industry; this would very quickly inform you as to industrial capability for that particular job and would do so more effectively than any general survey. Of course, both of these last two suggestions could be carried out; they are certainly not mutually exclusive.

Sincerely yours,

J. F. FAIRMAN,
Chairman, Nuclear Energy Committee.

BIG CHIEF DRILLING CO.,
Oklahoma City, Okla., December 7, 1959.

Mr. JOHN A. MCCONE,
Chairman, Atomic Energy Commission,
Washington, D.C.

DEAR MR. MCCONE: The Chamber of Commerce of the United States and its committee on commercial uses of atomic energy have been and continue to be vitally concerned with the degree to which the activities of the Atomic Energy Commission are directed so as to "strengthen free competition in private enterprise" as stated in the opening declaration of the Atomic Energy Act. Our meetings with you and your associates at the Commission have been extremely valuable in this connection and we look forward to meeting with you again on January 27, 1960.

We have given a great deal of thought and study to the recent Bureau of the Budget Bulletin No. 60–2, to the heads of executive departments and establishments, on the subject of "Commercial-Industrial Activities of the Government Providing Products or Services for Governmental Use." We are convinced that Atomic Energy Commission acceptance and implementation of the policy stated in Bulletin No. 60–2 and the review of its commercial-industrial activities will go a long way to "strengthen free competition in private enterprise."

As a result of our interest in Bulletin No. 60–2, I appointed a subcommittee on Government competition with industry of our committee on commercial uses of atomic energy. This subcommittee was assigned the responsibility of compiling specific examples of Government competition with industry in the atomic energy program that the national chamber has received from its members.

I am transmitting, with this letter, a listing of our subcommittee on Government competition with industry and some specific examples of commercial-industrial activities of the Government in the atomic energy program. We believe that a detailed evaluation of such cases is warranted under the terms of Bulletin No. 60–2. We hope that a public statement of the results of such a review will be made as a contribution to clarifying Government policy in this area. We expect to communicate additional examples to you in the near future.

We recognize and are pleased with the progress made by the Commission in reducing some of its activities which compete with industry and submit the enclosed examples in an attempt to assist in furthering this process. We know, from our constructive relationship with the Commission, that we share the basic belief that a strong atomic energy industry will be of great benefit to the American public and practices which retard progress in this area will be costly to the public.

We will be happy to discuss the enclosed examples with you and your associates and trust that we can be of further service to the Commission in connection with the objectives of Bulletin No. 60–2. We would appreciate your keeping us informed of the Commission's activity in this area and hope to discuss the matter with you when you meet informally with our committee on commercial uses of atomic energy.

Sincerely yours,

JACK H. ABERNATHY,
Chairman, Committee on Commercial Uses of Atomic Energy,
Chamber of Commerce of the United States.

CHAMBER OF COMMERCE OF THE UNITED STATES OF AMERICA,
Washington.

COMMITTEE ON COMMERCIAL USES OF ATOMIC ENERGY, SUBCOMMITTEE ON GOVERNMENT COMPETITION WITH INDUSTRY

Frank K. McCune, subcommittee chairman, vice president, Atomic Business Development Marketing Services, General Electric Co.
Howard Cadwell, president, Massachusetts Electric Co., and vice president, Yankee Atomic Electric Co.
Dr. V. L. Parsegian, dean, school of engineering, Rensselaer Polytechnic Institute.
James M. Phelan, president, Nuclear-Chicago Corp.
Dr. Philip N. Powers, president, Internuclear Co.
Dr. Chauncey Starr, vice president, Atomics International.
Edwin Vennard, vice president and managing director, Edison Electric Institute.
Charles H. Weaver, vice president, Westinghouse Electric Corp.
George M. Wunder, managing, Nuclear Metals Division, National Lead Co.

EXAMPLES OF COMMERCIAL-INDUSTRIAL ACTIVITIES OF THE GOVERNMENT IN THE ATOMIC ENERGY PROGRAM WARRANTING DETAILED EVALUATION UNDER THE TERMS OF BUREAU OF THE BUDGET BULLETIN NO. 60–2

I. FUEL ELEMENT FABRICATION

Substantial industrial capability in this area now exists going all the way from mining to the fabrication of reactor cores (except for enrichment processing). Activity in production fuel element fabrication at Government-owned facilities should cease unless it is clearly demonstrated that, in a particular instance, capable commercial fabricators cannot undertake the responsibility. Government laboratories and facilities have and are continuing to fabricate fuel elements for various research, testing, military, and production reactors which could and should be procured from industry. Specific examples which warrant review in accordance with the above policy and Bulletin No. 60–2 have been submitted by members of the national chamber. The following are some of these specific examples:

1. The Oak Ridge National Laboratory makes the fuel elements for most of its reactors. Examples include the bulk shielding reactor and the LITR.
2. The conversion and fabrication of fuel elements for the process heat reactor project to be built at Point Lomas, San Diego, Calif.
3. The conversion and fabrication of the fuel elements for the nuclear-rocket program (Project Rover).
4. The Savannah River site makes some fuel elements for its reactors. Savannah River is also doing fuel element development work. This includes the conversion and fabrication of fuel elements for the heavy water components test reactor being built at Savannah River.
5. Fuel elements for the Hanford site are fabricated in Government facilities.

II. RESEARCH AND DEVELOPMENT

Research and development work should be conducted in private facilities, except where it is clearly demonstrated that such are unavailable for a particular job. The policy of the Government should be to fully utilize and encourage the growth of industrial capacity rather than according preference to Govern-

ment facilities. Some specific examples, in this area, which warrant review under the above policy and Bulletin No. 60–2 are—

1. Oak Ridge National Laboratory's design of a high-flux isotope-producing reactor.
2. Brookhaven National Laboratory's preliminary design of the beam research reactor.
3. Oak Ridge National Laboratory's title 1 and title 2 design of ORR.
4. Argonne National Laboratory's title 1 and title 2 design of hot cells for its new research laboratory.
5. Sandia and Los Alamos design work for the Sandia test reactor.
6. The Government's University of California Radiation Labortory's design, test, and fabrication of nuclear ramjet engines.
7. Argonne National Laboratory's title 1 design of the process heat reactor.
8. Knolls Atomic Power Laboratory's work on a natural circulation reactor for the Navy.
9. Los Alamos' experimental work on thermionic cells to convert fission energy directly to electricity.
10. Oak Ridge National Laboratory's Instrument Development Section which in some instances is working on the development of instruments in competition with commercially available equipment.
11. Argonne National Laboratory's development of the Army low-power reactor.
12. Each of the major Government projects have developed their own, and different, hand and foot monitors, scalers, survey meters, and multichannel radiation analyzers in competition with commercially available equipment.

III. DEPLETED URANIUM

Essentially all areas of depleted uranium use could be supplied by industry. The following are examples of Government activities in this area warranting review:

1. Conversion of enriched and depleted uranium from UF_6 as required in the nuclear Navy for metal, alloys, or uranium compounds.
2. Depleted uretnium metal fo ran AEC shielding cask project at schenectady.

IV. PRODUCTION OF RADIOACTIVE ISOTOPES

The Government is currently producing certain radioactive isotopes in a commercial way (e.g. cobalt 60, iodine 131, carbon 14, sulfur 35, phosphorus 32). The demand for these radioactive isotopes is now at a level which makes commercial production feasible and commercial facilities exist which should be utilized.

V. IRRADIATION SERVICE

Preference should be accorded private irradiation facilities in place of the current preference for loading Government facilities first. This is the best way of encouraging more private capacity. Underloaded commercial facilities exist whereas it is our impression that the Government-owned facilities are heavily loaded. AEC's proctice of offering space in the Government-owned MTR and ETR should be limited to only those specific cases where private facilities are unavailable.

VI. SUPPLY OF VARIOUS MATERIALS, PRODUCTS, AND SERVICES

Adequate industrial facilities currently exist to produce and supply many material and services needed by the AEC that are now secured from Government facilities (both Government and contractor operated). The following are some examples warranting review:

1. Enriched uranium and/or pellets for the gas-cooled-reactor project at the Oak Ridge National Laboratory.
2. Enriched uranium for the nuclear ramjet project.
3. Enriched uranium metal and/or fabrication for the new Hanford production reactor.
4. Supply and/or fabrication of high purity cobalt for the High Intensity Radiation Development Laboratory at the Brookhaven National Laboratory.
5. Servicing of film badges by AEC contractors.

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6. Instrument production work at Los Alamos, Oak Ridge, and the University of California (Berkeley).
7. Chemical processing of cold industrial scrap.
8. Supply AEC's needs for thorium alloy, thorium oxide, thorium carbide, high-purity cobalt and radioisotopes.
9. Printing facilities at Government facilities.
10. Operation and maintenance of automotive equipment and transportation facilities (bus and rail) at Government installations.
11. Power distribution in connection with Government installations.
12. Communications systems at Government installations.
13. Machine shop facilities at the Argonne National Laboratory.

VII. REPROCESSING OF IRRADIATED FUEL ELEMENTS

It is recognized that the reprocessing of irradiated fuel elements represents an area that is difficult to assess commercially. However, there is no reason to believe that many chemical firms could not handle the job if pricing, regulatory, and load problems could be successfully met. While the Government is spending large sums on developing new processes which inhibit industrial investment in known processes it can speed the transition toward a desirable commercial mode of operation by making maximum use of industrial firms in research and development and possibly the construction and operation of reprocessing plants.

VIII. ATOMIC ELECTRIC POWER

Government competition with the private power industry through atomic electric power continues to be of major concern to us. We were pleased to receive the Commission's response to the national chamber's atomic energy industry policy statement indicating essential agreement with us in this area. We would like to take this opportunity to repeat a small segment of that statement relating to atomic electric power which we feel is essential in this connecton:

"The Federal Government should not own or operate atomic powerplants for commercial energy production. Aside from regulation, Government activity in the area of atomic power generation should be limited to research, development, experimentation, and the encouragement of wide industrial participation. As soon as the stated purpose of any Government experimental facility has been achieved, it should be disposed of. Should any Government experimental facility have a residual economically feasible use, it should be offered for sale. The production for sale to the public of electricity generated by means of atomic power should be the responsibility of the existing utility industry. Any interim production of atomic energy by experimental facilities at Federal Government atomic energy installations should either be used by the Government in the operation of such installations or disposed of on a nonexclusive basis to distributing utilities in the area without preference or discrimination."

MANUFACTURING CHEMISTS' ASSOCIATION, INC.,
Washington, D.C., December 2, 1959.

Mr. CHARLES G. MANLY,
Assistant Director for Commercial Activities,
Atomic Energy Commission,
Washington, D.C.

DEAR MR. MANLY: At the meeting of the Manufacturing Chemists' Association Nuclear Committee on October 15, which you, General Luedecke, and Ed Bloch attended, there was a discussion of private industry's ability to supply materials and services required by some of the AEC sponsored projects.

In order to have some concrete examples, we canvassed the members of the committee. One or more member companies have stated that they have the technical capability and existing production facilties for supplying materials and services included in the attached list. At the present time, we are checking to determine the total production capacity for each item and will supply you with this inforamtion at a future date.

Since these projects are nonroutine in nature and are not part of the Commission's plutonium or weapons program, it is felt that the materials and services could be supplied by industry without disturbing the Commission's routine operation.

If you desire any further information on this subject, please let me know.

Sincerely,

R. C. JOHNSON.

AEC sponsored projects for which MCA member companies have technical capabilities and productive capacity:

1. Conversion of all enriched and depleted uranium from UF_6 as required in the "nuclear Navy" for metal, alloys, or uranium compounds.
2. Depleted uranium for all activities at the national laboratories with specific attention directed to the conversion of depleted uranium from UF_6 and the fabrication of blanket fuel elements for the zero power reactor at Argonne National Laboratory.
3. Conversion from UF_6 of depleted uranium required for shielding cask at Bettis Field representing approximately 40 tons of cylindrical casting.
4. Conversion and fabrication of fuel elements for the process heat reactor project to be built at Point Lomas, San Diego, Calif.
5. Enriched uranium oxide and/or pellets for the gas-cooled reactor project at ORNL.
6. Conversion and fabrication of fuel elements for the AEC's nuclear rocket program at Livermore.
7. Supply of enriched uranium metal for ETR and MTR fuel elements.
8. Enriched uranium metal and fabrication of fuel for the NPR at Hanford.
9. Depleted uranium metal for AEC shielding cask at General Electric, Schenectady.
10. Supply and/or fabrication of high purity cobalt for the high-intensity radiation development laboratory at the Brookhaven National Laboratory.
11. Production of uranium for heavy water components test reactor being built at Savannah River.
12. Conversion and fabrication of uranium elements required for subcritical training reactors for educational institutions.
13. Production of enriched uranium metal for the Piqua and Hallem reactors.
14. Supply of thorium oxide for the homogeneous development program at ORNL.
15. Supply of thorium metal for special projects at Los Alamos, Sandia, and Lawrence Radiation Laboratory at Livermore.
16. Recovery of cold fabrication scrap, both high and low enriched, from all of the above projects.

ATOMIC ENERGY COMMISSION,
Washington, D.C., February 10, 1960.

CHAMBER OF COMMERCE OF THE UNITED STATES,
Committee on Commercial Uses of Atomic Energy
(Attention: Jack H. Abernathy, Chairman).

NATIONAL ASSOCIATION OF MANUFACTURERS,
Nuclear Energy Committee
(Attention: J. F. Fairman, Chairman).

MANUFACTURING CHEMISTS' ASSOCIATION, INC.
(Attention: R. C. Johnson).

GENTLEMEN: Your letters which submitted examples of Commission activities which you believe may constitute competition with industry within the meaning of Budget Bulletin 60–2 cover to a great extent the same activities. For this reason, a single reply seems appropriate.

In carrying out its statutory responsibility to encourage widespread use of atomic energy in such a manner as to strengthen free competition in private enterprise, the Commission has maintained a firm policy to procure goods and services from private industry wherever practical. From inception the Commission has turned to private industry to construct for the Government the major facilities required for the production of fissionable materials and for the comprehensive research and development program contemplated by the Atomic Energy Act. Government ownership of such facilities was found to be essential, since no reasonable way could be found to provide adequate incentives for private ownership of such specialized and costly facilities.

Further, as a means of utilizing and expanding the skills of the entire national economy and to take advantage of "know-how" and proven business experience, the Commission engaged industrial companies and educational institutions to operate and manage these facilities.

The continued use of existing Government facilities is clearly necessary in the public interest for the production of fissionable materials, the assembly of

weapons, and the conduct of most advanced research and development. The facilities and skills of private industry are and will be employed when they are adequate to carry out specific activities in the military and peaceful applications of atomic energy at the rate required to attain our national objectives. It should be emphasized, however, that the Commission must exercise care in discontinuing a specific activity to assure that related activities which are closely integrated do not unduly suffer in development, cost or efficiency by reason of the divorcement.

In this new industry, the tempo of technological developments in many instances does not permit establishing precise specifications or assure a volume of repeat orders necessary to attract the investment of private capital in the specialized facilities, equipment, and personnel required. Consequently, there still remain areas of the Commission's work where it is premature to expect that such work can be procured from private industry on a competitive basis. Furthermore, we have a responsibility to avoid the concentration of services with a single source of supply, particularly under circumstances where such concentration might constitute a preemption of the market which would discourage widespread participation in the uses of atomic energy.

We recognize that as the atomic energy industry grows there will be areas of activity appropriate for transfer from Government to private operation. Numerous products and services formerly provided exclusively in Government facilities are now procured commercially, major examples being fabricated beryllium shapes, hafnium and zirconium products, uranium hexafluoride, and fuel elements for many nonproduction reactors. It is Commission policy to contract with private firms for the performance of title I and title II engineering of both nuclear and nonnuclear portions of the plant unless the nature of the work and the circumstances clearly dictate otherwise. Also, it is Commission policy, announced in 1956, that the Commission will cease to provide any service or product to the public whenever such service or product can be provided under reasonable terms by private industry.

The examples presented in your letters are concerned, in large measure, with specific activities within a production or research and development complex. Many of these activities have been carefully studied over a period of years for feasibility of separate contracting. A major reason for contracting with industrial concerns was to have our facilities operated in accordance with sound and proven business practices. Such business practices include procuring goods and services from specialized concerns wherever such concerns can satisfactorily furnish the product required and when to do so is sensible, economical, and consistent with the efficiency of integrated operations.

A typical example of the practices applied is contained in the following statement of policy of one of our major industrial contractors:

"The determination of the method by which these services will be performed is made in accordance with normal private industrial criteria, modified to the extent necessary to comply with existing AEC directives and applicable Federal law.

"These criteria include, but are not necessarily limited to, the following:

"1. *Costs.*—By what method and by whom can the service be performed at the least possible cost?

"2. *Relationship to the manufacturing process.*—How dependent is the process on the service being studied? Would an interruption in the service have a serious detrimental effect on the process?

"3. *Availability from commercial sources.*—Is the service available commercially at a competitive price? Is there sufficient productive capacity in commercial sources to assure delivery of needed quantities? Is the geographical location of the source or sources an advantage or disadvantage?

"4. *Volume of work.*—Is the volume sufficient to make it feasible for contracting?

"5. *Security requirements.*—What effect do the related security requirements, if any, have on the method of performing the service?

"6. *Developmental aspects.*—Is the design of the material or service sufficiently clear so that it is possible to contract without excessive cost?

"7. *Contamination.*—Is the material contaminated above limits which can be released to commercial sources?"

As applied to the Commission's operations, such typical business criteria are supplemented as applicable by other Government criteria such as those contained in the recent Budget Bulletin 60–2. Such supplementation provides, for example, that the elements of cost as provided for in Budget Bulletin 60–2 be considered

in making comparisons between the cost of providing services at the Government-owned plant and the cost of procurement from commercial sources. Furthermore, our contractors are specifically advised of activities where it is Commission policy to subcontract to private industry. It is our practice to make surveys and appraisals of operations at Government-owned installations to review the continued application of these criteria. By effective application of such criteria, evidenced by thousands of contract actions annually for research, engineering, construction, equipment, and supplies, a wide range of enterprise in the atomic energy industry is being developed.

For each of the activities cited as examples in your letters, we have prepared comments which are attached. Many of the examples are in areas of future activities in which we look forward to either initial or increasingly greater industrial participation on a commercial basis, while others generally fall into the following categories:

1. Activities where industry is already engaged in the normal conduct of the work.
2. Activities which are closely integrated with plant operation and in accordance with accepted industry practice should remain integrated.
3. Activities which are in such a fundamental stage of development that the coordinated use of the skill and facilities at Government-owned installations is still required.
4. Activities where large volume is dependent upon military requirements and where extremely large plant investments have already been made by the Government, or where the volume of activity is so small, sporadic, and nonstandardized as to make it impractical or uneconomical to contract for separately.
5. Activities for which there is no known competitive commercial capacity.

We trust that this letter and our attached comments on the examples you have cited will provide a better understanding of the Commission's policy and practice regarding the utilization of private enterprise in fulfilling its responsibilities under the Atomic Energy Act. We will continue to examine commercial-industrial activities of the Commission in the light of the growing capability in the private atomic energy industry. For the purpose we will welcome at any time expressions from industry of their capability to provide additional services and products through ordinary business channels.

Sincerely yours,

JOHN F. FLOBERG, *Acting Chairman.*

ATTACHMENT TO THE COMMISSION'S REPLY TO THE CHAMBER OF COMMERCE OF THE UNITED STATES (C. of C.), THE MANUFACTURING CHEMISTS' ASSOCIATION (MCA), AND THE NATIONAL ASSOCIATION OF MANUFACTURERS (NAM)

(Comments on AEC activities cited as examples of competition with industry within the scope of Bureau of the Budget Bulletin No. 60–2)

I. FUEL ELEMENT DEVELOPMENT AND FABRICATION

A vital part of any reactor is the fuel element with which it operates; the success or failure of a particular reactor experiment, prototype, or power reactor depends strongly upon whether a suitable fuel is available. Just what constitutes a suitable fuel depends upon the purpose of the experiment. Thus, in a zero power reactor the composition, weight, dimensions, and uniformity of the fuel are of controlling importance; resistance to irradiation damage is of very little interest. On the other hand, fuel for a high temperature, high burnup reactor must have a high degree of irradiation stability. Thus, the fuel must be tailored to fit the experiment. The fuel itself is experimental in nature. In the continuing effort to improve the fuel, successive loadings of the same experimental reactor are usually different, each type of loading being used only once. The Commission carries on an extensive program in the development of suitable fuel elements; this work includes the development of fuel and cladding materials, the determination of their physical, mechanical, and thermal properties, and their behavior under irradiation and thermal cycling, and development of methods of melting, casting, fabrication, and testing.

This program is so broad that it involves not only most of the Commission's laboratories and operating contractors but also a very large portion of the program is being conducted by commercial firms. In an action announced

March 13, 1959, contracts with contemplated expenditures totaling over $25 million were awarded to 18 firms.

Outside of purely experimental tasks which must be closely coordinated with other development work, it is the Commission's general policy to obtain fuel element manufacturing services, other than for the production reactors at Hanford and Savannah River, from commercial sources. Our general policy is to procure reactor materials from commercial suppliers whenever adequate facilities, skills, and experience exist in commercial laboratories and the time schedule can be met. In addition, whenever it is feasible, we are now procuring end items containing nuclear materials rather than separately procuring materials and fabrication. The ability of industry to produce according to requirements has increased very appreciably in the last 5 years or so and more and more of the requirements are being met from industrial sources.

To illustrate the extent to which procurement from commercial sources has progressed, there follows a tabulation of the enriched uranium which has been furnished to all sources outside the weapon's production chain, showing the proportion furnished in the form of UF_6 compared to that furnished in a form requiring additional processing in AEC facilities:

Fiscal year	Total (kilograms)	Furnished in form other than UF_6		Furnished as UF_6	
		Kilograms	Percent of total	Kilograms	Percent of total
1958	45,000	21,000	47	24,000	53
1959	116,500	6,500	6	110,000	94
1960					
5 months through Nov. 30, 1959	42,500	1,500	4	41,000	96

Comments on specific cases mentioned in the letters follow:

Experimental gas cooled reactor

C. of C. VI–1: "Enriched uranium and/or pellets for the gas cooled reactor project at the Oak Ridge National Laboratory."

MCA–5: "Enriched uranium oxide and/or pellets for the gas cooled reactor project at ORNL."

NAM–A1b: "Supply of enriched uranium oxide, pellets or metal, for gas cooled reactor project: * * *"

Oak Ridge National Laboratory (ORNL) is currently preparing the design and specifications for the fuel element and materials so that the core loading can be procured from industrial sources following normal procurement practices. In the development of this element, ORNL has attempted to procure from industrial sources enriched UO_2 and/or UO_2 pellets which meet its specifications. Experience to date has been disappointing in that ORNL has been unable to obtain the necessary quantities of acceptable materials. The yields have been disappointingly low, the schedules have had to be changed at the convenience of suppliers, and in all cases ORNL has obtained the pellets it required only by relaxing the specifications.

Process heat reactor

C. of C. I–2: "The conversion and fabrication of fuel elements for the process heat reactor project to be built at Point Lomas, San Diego, Calif."

MCA–4: "Conversion and fabrication of fuel elements for the process heat reactor project to be built at Point Lomas, San Diego, Calif."

NAM–A1a: "Conversion from UF * * * for process heat reactor to be built at Point Lomas, Calif.

The invitation to reactor manufacturers to supply the reactor and certain primary system components included all of the internals and the reactor core with 14 percent spares. This invitation was issued in October 1959 and a number of proposals from manufacturers had been received and were being evaluated when the letters to which this reply is addressed were received. All of the fixed price proposals received contemplate commercial supply of these fuel elements by the selected proposer. The Commission is supplying UF_6; all other services will be obtained commercially.

Bulk shielding reactor and low intensity test reactor

C. of C. I–1: "The Oak Ridge National Laboratory makes the fuel elements for most of its reactors. Examples include the bulk shielding reactor and the LITR."

Private sources of supply for procurement of replacement fuel elements for the LITR and BSR are not used for the following reasons: The demand for these elements, based on data accumulated during the past 5 years, indicates the follwing average yearly requirements: LITR, 15 elements; BSR, 5 elements. The number of replacement elements is low because of the low power at which these reactors operate. (The BSR operates from zero to 100 kilowatts and the LITR at 3 megawatts.) Since the BSR and LITR are used to test experimental fuel assemblies, about 25 percent of the replacement fuel elements are not standard. Dies and fixtures are available for these specific elements so that the small number required can be produced by laboratory staff as "fill in" work.

Materials testing reactor and engineering test reactor

MCA–7: "Supply of enriched uranium for ETR and MTR fuel elements."

NAM–A1b: "Supply of enriched uranium * * * metal for * * * ETR and MTR at Arco, Idaho. * * *"

The original MTR fuel elements were fabricated at Oak Ridge prior to availability of commercial sources. The first MTR replacement also was the first core for an AEC reactor to be obtained from a commercial fabricator. Since then, all cores have been fabricated commercially:

MTR:
- Replacement quantity 1,[1] Babcock & Wilcox.
- Replacement quantity 2,[1] Clevite.
- Replacement quantity 3,[1] General Electric.

ETR:
- Original quantity, Babcock & Wilcox.
- Replacement quantity 1,[1] General Electric.

While the Government furnished metal in each of these cases, the statistics previously cited indicate the effectiveness of AEC's efforts to obtain the processing services from commercial sources. In the most recent case (MTR replacement No. 3) the invitation requested proposals on both bases (i.e., use of commercially procured metal or use of Government-furnished metal). The decision to use Government metal was based on the price differential analyzed in accordance with BOB Circular 57–7 (the predecessor to BOB Circular 60–2).

Nuclear rocket program—Project Rover

C. of C. I–3: "The conversion and fabrication of the fuel elements for the nuclear-rocket program (Project Rover)."

MCA–6: "Conversion and fabrication of fuel elements for the AEC's nuclear rocket program at Livermore."

NAM–A1a: "Conversion from UF_6 and fabrication of fuel elements for AEC nuclear rocket program at Livermore; * * *"

Responsibility for all research and development for the nuclear propulsion of rockets (Project Rover) is assigned to the Los Alamos Scientific Laboratory. Enriched uranium metal for Rover fuel elements is drawn from the inventory maintained at Los Alamos for the weapons program, and fuel element fabrication work is performed in the same facility in which development of uranium fabrication techniques is carried on for the weapons program. The material for Rover is a relatively small proportion of the amount fabricated in that facility.

At present, every Rover reactor is different. Fuel element requirements and technology are still in development, and cannot yet be described by definite and inclusive specifications. In view of the frequent and last-minute changes in design details and characteristics to be sought, fuel element fabrication for the current, research-type Rover systems must continue as an activity performed directly by the Los Alamos Scientific Laboratory.

At later stages when there are repetitive tests of a single design, the degree of standardization may permit commercial procurement of both the conversion and fabrication of uranium for Rover fuel elements.

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[1] One year's supply.

Naval reactors

C. of C. III–1: "Conversion of enriched * * * uranium from UF_6 as required in the 'nuclear navy' for metal, alloys or uranium compounds."

MCA–1: "Conversion of all enriched uranium from UF_6 as required in the 'nuclear navy' for metals, alloys or uranium compounds."

NAM–A1b: "Supply of * * * all uranium alloys or compounds for the 'nuclear navy.'"

Practically all of the highly enriched uranium utilized in these cores is obtained from scrap metal in the form of trimmings left from material utilized in the weapons program. These trimmings are chopped into small pieces and shipped to the core manufacturer who performs all further processing and fabrication operations involved in the manufacture of the fuel elements.

There are now five private companies supplying reactor cores for the naval reactors program on a fixed price, competitive basis. Through calendar year 1950, contracts totaling approximately $200 million have been awarded to private industry for fuel fabrication.

These companies now manufacture all reactor cores for the naval reactors program with the exception of some first reactor cores of a type which are of a highly developmental nature. However, many of the parts, even for these first developmental cores, are manufactured by private industry rather than in the Commission's Bettis and Knolls Atomic Power Laboratories. In this connection, it is also significant that a substantial portion of these parts for developmental cores which are subcontracted to private industry are in themselves of a developmental nature. This type of subcontracting from the Bettis and Knolls Atomic Power Laboratories to private industry has been increasing, commensurate with industry's capability to handle such work. Thus, the fuel fabrication work that remains in these laboratories is only that which is of a highly developmental nature and pertains specifically to the first core of a new design being developed at the laboratory.

Subcritical training reactors

MCA–12: "Conversion and fabrication of uranium elements required for subcritical training reactors for educational institutions."

NAM–A1a: "Conversion from UF_6 and fabrication of fuel elements * * * for subcritical training reactors * * *."

Educational institutions, as of January 1960, possess or are planning to acquire 2 enriched uranium and 84 natural uranium subcritical training reactors. The fuel is furnished by the AEC without charge to the institutions. The enriched fuel is fabricated commercially and the natural uranium fuel is furnished by the AEC from its supply of reject slugs at Savannah River. It is anticipated that in the next several years educational institutions will require approximately 25 new subcriticals per year.

Since these are vital to the educational programs on which both industry and government must rely for new trainees for this expanding industry, it is desirable to provide the facilities so that the greatest number of training programs can benefit. Use of material which does not meet the production reactor specifications is a suitable and economical means of increasing the effectiveness of the training program.

Nuclear Ramjet project

C. of C. VI–2: "Enriched uranium for the nuclear Ramjet project."

On the original order for fuel for the Tory II–A, the conversion from UF_6 to U_3O_8 was performed by the Commission's Oak Ridge Y_{12} plant. Y_{12} was used for this job on thte basis of a technical evaluation of capability. Because of the unique and stringent chemical specifications for the U_3O_8 it was determined that no source other than the highly experienced Y_{12} plant could be reasonably expected to perform this conversion job on the required schedule and at an acceptable cost. It is anticipated that future requirements for converison of UF_6 and the fabrication into fuel materials will be obtained commercially, providing that commercial capability exists to provide these services at reasonable cost and upon the required schedules.

Piqua and Hallam reactors

MCA–13: "Production of enriched uranium metal for the Piqua and Hallam reactors."

Present plans for both the Piqua and Hallam reactor projects are that the fuel conversion will be done commercially. Fabrication in both cases will be by

Atomics International, the AEC prime contractor for construction of the reactor. In both cases arrangements have not yet been completed.

Heavy water components test reactor

MCA–11: "Production of uranium for heavy water component test reactor being built at Savannah River."

C. of C. I.4: "Savannah River is also doing fuel element development work. This includes the conversion and fabrication of fuel elements for the fuel element heavy water test reactor being built at Savannah River."

NAM–Ala.: "Conversion from UF and fabrication of fuel elements for heavy water components test reactor at Savannah River."

The driver and fuel elements for the HWCTR are not being manufactured at the Savannah River plant. This work is being carried out in commercial facilities, Nuclear Metals, Inc., Concord, Mass., under a Du Pont subcontract. The contract for this work was awarded after a survey of six fuel element manufacturing concerns which appeared to have the experience and facilities for making tubular metallic fuel elements. In the case of the driver tubes, the small number required resulted in little interest by industry in this operation. It was indicated, however, that should significantly larger numbers of tubes be required, industry would be interested in submitting bids. In the case of the HWCTR fuel elements, these are still in the development stage. Considerable development work and testing are required before establishing a firm design for this element. Nuclear Metals has been engaged to do much of the development work and to supply the necessary test elements during the development period.

Savannah River and Hanford production reactors

C. of C. I–4: "The Savannah River site makes some fuel elements for its reactors. Savannah River is also doing fuel element development work."

C. of C. I–5: "Fuel elements for the Hanford site are fabricated in Government facilities."

The manufacture of fuel elements for production reactors has been accomplished in Government-owned facilities operated by industrial contractors since the initiation of production activities during World War II. As the AEC program expanded, additional capability was provided to meet the increased requirements. The current operating facilities at Fernald and Weldon Spring represent a Government investment of about $165 million. These facilities are operated by industrial companies under cost-type contracts.

There is no privately owned industrial facility in being which can meet the requirements of the production program. It is not considered feasible to contract for production reactor fuel element fabrication in privately owned facilities at fixed prices, chiefly because of the frequent and substantial changes which are required in fuel element types, specifications, and quantities resulting from new conditions in the production reactors. The operation of fuel fabrication plants must be closely integrated with production reactor operations and thereby with weapons production schedules. In order to accommodate new operating requirements without delay, any fixed price arrangement with a private supplier would necessarily involve price renegotiation to offset changes in costs as requirements change. Such an arrangement would approach closely a cost-type contract similar to those which now exist between the companies operating AEC's fuel fabrication facilities and the AEC.

Because the level of production is directly related to weapons requirements and reactor performance both of which are subject to substantial change on short notice, because it is difficult to set firm specifications, because civilian requirements are so low that this capacity could not be fully utilized for peaceful purposes for many years, and because of the large investment already made in AEC plants, the establishment of duplicate fabrication facilities by industry would not be in the best interests of either the Government or industry.

New production reactor

C. of C. VI–3: "Enriched uranium metal and/or fabrication for the new Hanford production reactor."

MCA–8: "Enriched uranium metal and fabrication of fuel for the NPR at Hanford."

NAM–A1b: "Supply of enriched uranium * * * metal for * * * NPR at Hanford * * *"

The new Hanford production reactor, which is being built on an accelerated time schedule, will use metallic uranium fuel elements under temperature conditions similar to those which are found in current power reactors. This operating condition, representing a substantial departure from other AEC production reactors, requires that an extensive fuel element process development program be conducted to develop specifications and fabrication and testing techniques. This work is being performed concurrently with the design and construction of the reactor. To avoid delay in startup of the new reactor, the installation of the fabrication facilities must also proceed concurrently with the construction of the reactor, even though firm specifications are not available. Since even process specifications are not firm, and would be subject to change as operating experience is gained, contracting with industry for these fuel elements at this time could only result in the AEC's entering into a cost type contract for the operation, similar to those now in effect between AEC and the contractors operating plants. Since the AEC already has in existence or will install for the development program much of the equipment required to process the uranium and fabricate the proposed type of fuel elements, the incremental AEC investment required will not be major.

However, since industry has indicated possible interest and capability for performing these operations, arrangements have been made for an industrial group to review the question of production of NPR fuel elements in private facilities. Their report has now been received but the Commission has not had an opportunity to evaluate its recommendations.

II. REACTOR DESIGN AND DEVELOPMENT

General

NAM-Cld: "Design, construction and testing of reactors, reactor prototypes, and reactor experiments for which industrial capacity and capital exists."

Research, development, and experimentation in the general field of advanced reactor development by AEC laboratories is a prime responsibility of such installations. The chamber of commerce letter itself recognizes this role of the AEC in section VIII of its letter. The design of an advanced reactor cannot in reality be divorced from the development effort leading up to the actual prototype reactor itself.

To the maximum extent consistent with the paramount objective of obtaining the desired technical data for which it is necessary to build a prototype of a particular reactor type, it is the intention of the Commission to construct prototype plants under cooperative arrangements with utilities, public or private. It is highly desirable to have power reactor prototypes integrated into power systems to secure information on compatibility and performance and on maintenance and operation. The Commission plans to construct such facilities on its own sites only if responses to invitations are not received or are not acceptable. All power reactor prototypes constructed by the Commission, whether at a utility or Commission site, are designed and constructed under contract by private companies with the Commission generally specifying only the reactor conceptual design, approximate power size, and general objectives, plus such specific parameters as are necessary to assure obtaining the information which the reactor is intended to provide.

With respect to experimental reactors and reactor experiments, these are for the most part designed by Commission laboratories, with that portion of the design which is not a direct outgrowth of the experimental program being furnished by architect-engineers. Among the more important reasons for assigning to the laboratories the primary responsibility for such projects are: (1) They are generally merely an extension of a planned laboratory program and as such, are of more benefit when designed, operated, and altered, as needed to accomplish the project objective, by the laboratory personnel: (2) due to the experimental nature of the project, specifications are developed as the work proceeds and a complete set of specifications is not available for the solicitation of bids from industry: (3) in many cases, the experiments are merely modifications of previous experiments; and (4) ancillary equipment already existing at Commission sites can be used which reduces the cost of the project and the time and effort required for setting up the experiment.

Detailed comments are given below and, in general, these comments are applicable to the general design, construction, and testing of AEC reactors. Current policy is that conceptual design will be made by the best qualified organization. However, title I and title II type work is normally contracted for with engineering firms.

Oak Ridge research reactor

C. of C. II–3: "Oak Ridge National Laboratory's title 1 and title 2 design of ORR."

The Oak Ridge National Laboratory had responsibility for the design of the ORR. However, titles I and II design services required for this facility were by no means accomplished exclusively by members of the ORNL engineering staff. A private organization—the McPherson Co. of Greenville, S.C.—performed a significant amount of the title II design work. The McPherson Co. participation in the design of the ORR included the design and preparation of working drawings and specifications for the complete reactor building, building services, utilities, reactor shield, reactor pool, and reactor cooling system. Oak Ridge National Laboratory, as the Commission's operating contractor, had direct responsibility for initiating and developing the overall concept for the facility, for the preparation of design criteria for all phases of the project, and for the definitive design of the reactor proper including instrumentation and controls.

The latest figures on total cost of the ORR show that less than 6 percent was expended by Oak Ridge National Laboratory engineering forces on design which could be considered as title I or title II engineering. Approximately one-third of the 6 percent was expended in preliminary work required to develop design criteria and specifications necessary for the design work to proceed. The remaining 4 percent was expended in coordination of the work with the architect-engineer and in design of the reactor proper and the reactor control system.

High flux isotope reactor

C. of C. II–1: "Oak Ridge National Laboratory's design of a high-flux isotope producing reactor."

It is anticipated that all title I and title II design of all portions of this job will be performed by an architect-engineer except for the design of the core and control systems. The control system components will be purchased from industry. Those portions of the job to be designed by an architect-engineer are a major fraction of the project.

The performance of this reactor will exceed by a large factor the performance of any existing reactor and is higher by a factor of nearly 2 than any other proposed high-flux reactor. It represents a sizable extrapolation of existing technology. In order to accomplish the research aims of the reactor it is necessary to advance the limits of current technology. We believe it to be the purpose of our national laboratories to perform this type of development.

Beam research reactor

C. of C. II–2: "Brookhaven National Laboratory's preliminary design of the beam research reactor."

The high-flux beam reactor will be used principally for research projects that require external beams of neutrons at both thermal and epithermal energies. The conceptual design study of a new and advanced research reactor was largely an effort to develop the best compromise of the needs of the experimentors, the actual performance of a chosen fuel and moderator array as determined by critical experiments, and engineering considerations of cost, safety, and general feasibility. Even on this conceptual study Brookhaven was assisted by an industrial company, and in July 1959 statements of interest concerning all phases of the design, equipment procurement, and management of construction of the reactor were solicited from 12 industrial companies. Nine proposals were subsequently received, and we are currently negotiating with one of the companies for this work.

Sandia test reactor

C. of C. II–5: "Sandia and Los Alamos design work for the Sandia test reactor."

As of December 31, 1959, this facility was 31 percent complete and is expected to go critical in late 1960.

All design aspects of the building and practically all design aspects of the reactor and associated equipment were handled through contracts with outside concerns. The designs of the reactor and associated equipment were based almost entirely on other components and fuel elements already in existence and involved only minor design modifications. The total design effort for the reactor and associated equipment was covered by approximately $75,000 in

outside design contracts plus approximately 4 man-years of combined Sandia and Los Alamos time over a 3-year period. The Sandia-Los Alamos effort in this area was the minimum necessary to keep Sandia personnel sufficiently knowledgeable to insure that it would get what it needed to do its job and to provide a background for the operation of the reactor.

Process heat reactor

C. of C. II–7: "Argonne National Laboratory's title I design of the process heat reactor."

The ANL made an evaluation study of those reactor concepts which are proven to see if any such concept is particularly suitable for this application. The AEC also requested the Laboratory to provide a report on the conceptual design for the selected reactor concept and an outline for the research and development program for such a reactor. The title I design of the process heat reactor was not performed by Argonne but by Sargent & Lundy.

Natural circulation reactor

C. of C. II–8: "Knolls Atomic Power Laboratory's work on a natural circulation reactor for the Navy."

The development of a reactor plant for naval operation is quite different in many respects from the development of a stationary reactor plant. The compactness of the reactor system, the high-power density, the shock and vibration requirements, the maneuvering capabilities, and the operation of the plant under varying conditions of inclination give rise to problems not encountered in a land plant. The natural circulation reactor plant is a new concept for naval application and its successful and timely completion as well as its further advancement requires full exploitation of pertinent naval reactor technology. The Commission laboratories which have specialized in naval research and development work for about 10 years are, to our knowledge, the only organizations having the necessary technical talent, experience, and special facilities for undertaking this project in the most expeditious manner.

Army low-power reactor

C. of C. II–11: "Argonne National Laboratory's development of the Army low-power reactor."

NAM–Cle: "The first reactor in the Army low-power reactor program was fabricated by an industrial concern at its own facilities, but the second will be fabricated in a Government-owned facility."

We assume that the SM–1 plant at Fort Belvoir is the "first reactor" and the SL–1 (formerly ALPR) at the National Reactor Testing Station is the "second."

In the light of a known interest of the Department of Defense in a nuclear powerplant of approximately one-tenth the capacity of the SM–1 at Fort Belvoir, six separate reactor concepts were investigated to determine which could best meet the requirements of the Department of Defense. These studies were made between January and June 1955. Of the various systems investigated, the boiling water system study by the Argonne National Laboratory appeared to be most suitable for this purpose.

Inasmuch as there was no industrial experience with power reactor systems developed at that time, Argonne was requested to undertake development and construction of the prototype 200– to 300–k.w.e. plant which the Department of Defense requested in September 1955. In the course of constructing this plant, Argonne used subcontracts with many industrial firms. An industrial firm was awarded a contract to fabricate the fuel elements but defaulted because it was unable to fabricate elements meeting the prescribed standards. In order that the project completion date would not be jeopardized, the fabrication of the core was undertaken by Argonne Laboratory. Since completion the plant has been operated by Commission engineering.

III. THORIUM

C. of C. VI–8: "Supplying AEC's needs for thorium alloy, thorium oxide, thorium carbide * * *."

MCA–14: "Supply of thorium oxide for the homogeneous development program at ORNL."

MCA–15: "Supply of thorium metal for special projects at Los Alamos, Sandia, and Lawrence Radiation Laboratory at Livermore."

NAM–Cla: "Supply of thorium oxide for homogeneous reactor development at ORNL."

NAM–C1b: "Supply of thorium metal for special projects at Los Alamos, Sandia, Lawrence Radiation Laboratory at Livermore."

The AEC presently has no production capacity either operating or available for the processing of thorium to metal. A small pilot plant for preparation of special types of thorium oxide powders is in operation at ORNL. Several years ago a thorium metal pilot plant was built at Fernald site and operated for a short period. Since the anticipated requirements for thorium which were the basis for the Fernald pilot plant effort did not materialize, the facility was shut down in 1955 and has been dismantled. During its period of operation, the plant produced a small inventory of thorium metal and compounds from which the small needs which have developed since 1955 have been supplied. It is intended that future requirements of comparable size would continue to be supplied from this inventory as long as available. The ORNL pilot plant, on the other hand, is preparing thorium oxide powders in an effort to produce oxide having desirable slurry properties for use in the homogeneous reactor program. Oak Ridge has also procured sample quantities of oxide from industry for testing. Development work on preparation of acceptable powders supported by AEC funds has been carried out by ORNL and several private companies. The development program as ORNL is still underway. At such time as an oxide has been developed having the desired slurry properties for which a specification can be set, we would seek to obtain thorium oxide for use in homogeneous reactors from commercial sources.

Current thorium operations are limited to development efforts on the utilization of this element in AEC programs. There are some indications that there may be a continuing requirement for modest quantities of thorium metal which would exceed the current inventory. Should such develop, AEC will obtain the metal by procurement from commercial sources.

IV. DESIGN OF FACILITIES AND EQUIPMENT

Hot cells at Argonne National Laboratory

C. of C. II–4: "Argonne National Laboratory's title 1 and title 2 design of hot cells for its new research laboratory."

It is assumed that reference is made to the hot cell area in wing F of the Fuels Technology Center, now under construction. The title 1 and title 2 designs of the building were carried out completely by a private architect-engineer (Singmaster & Breyer) on the basis of preliminary designs prepared by Argonne. The design of the manipulator, windows, and internal cave hardware is being carried out by Argonne because of the experimental nature of the design concept. In this particular case the cave equipment is being designed so that the operations can be carried out for extended periods of time without the need for access by personnel. The design concept represents a complete departure from present operating techniques and requires a large advancement in all aspects of remote handling equipment. This new research metallurgy facility must be gastight to contain an inert atmosphere. No existing type of master slave manipulator is designed to operate under these conditions. Although the need for this new approach to remote handling has been discussed in open forums, no commercial company is working on this problem to the best of our knowledge.

It was also felt that the design of these features should be carried out by scientists and engineers who have already used such facilities and are acquainted with other problems in the design of remote handling and viewing systems.

Nuclear ramjet engines

C. of C. II–6: "The Government's University of California Radiation Laboratory's design, test, and fabrication of nuclear ramjet engines."

The function of this program is to determine the feasibility of and construct a nuclear reactor as a ramjet engine and does not include design, test, and fabrication of nuclear ramjet engines on a production basis. The Laboratory is subcontracting as much of this project as is feasible, considering the technical requirements and schedules involved. Subcontracts with industry currently amount to about 45 percent of the Laboratory's budget for the project.

Thermionic cells

C. of C. II–9: "Los Alamos' experimental work on thermionic cells to convert fission energy directly to electricity."

This item refers to the "plasma thermocouple," a present research project at the Los Alamos Scientific Laboratory. As far as we are aware, the basic

idea originated at LASL where technology in the exotic materials involved (uranium and zirconium carbide), scientific competence, and adequate laboratory facilities required are available.

This field of research is unclassified and completely open to industry. The AEC welcomes parallel research by industry and the publication of the results of such research. LASL has published numerous documents in this area and has briefed many industrial organizations upon their work. We encourage our laboratories to undertake frontier research of this nature.

V. DEPLETED URANIUM

C. of C. III–1: "Conversion of depleted uranium from UF_6 as required in the 'nuclear Navy' for metal, alloys, or uranium compounds."

C. of C. III–2: "Depleted uranium metal for an AEC shielding cask project at Schenectady."

MCA–2: "Depleted uranium for all activities at the national laboratories with specific attention directed to the conversion of depleted uranium from UF_6 and the fabrication of blanket fuel elements for the zero power reactor at Argonne National Laboratory."

MCA–3: "Conversion from UF_6 of depleted uranium required for shielding cask at Bettis Field representing approximately 40 tons of cylindrical casting."

MCA–9: "Depleted uranium metal for AEC shielding cask at General Electric, Schenectady."

NAM–A2a: "Supply of blanket fuel elements for zero power reactor at Argonne National Laboratory."

NAM–A2b: "Conversion from UF_6 of depleted uranium required for shielding cask at Bettis Field."

NAM–A2c: "Supply of depleted metal for shielding cask project at Schenectady."

Depleted uranium metal is used to a very limited extent in the naval reactors program as a shielding material in certain refueling equipment where compactness is required. Specifically, it has been used in the refueling equipment for the S3G and A1W type reactor plants. The depleted uranium for this equipment was fabricated into the desired shapes at Oak Ridge. The events leading to the decision to do the work at an AEC facility can be summarized as follows: In 1957, representatives from 11 private industrial concerns were invited to a prebid conference called to determine whether commercial vendors were technically capable of fabricating the depleted uranium shielding components for the S3G refueling machine developed and being manufactured by the United Shoe Machinery Corp. Three companies responded. As a result of this conference, the decision was made to perform the fabrication work at Oak Ridge because the capability of the three interested commercial vendors was uncertain, whereas it was evident that Oak Ridge had an established capability to perform this work. All three of the interested vendors lacked experience in casting the required depleted uranium alloy, and it was questionable whether their facilities could handle the size of the castings required. Similarly, starting in 1956, the United Shoe Machinery Corp. designed and developed for the Bettis Laboratory a maintenance and refueling machine for use with the A1W type 1 and 2 reactor cores. Depleted uranium for this machine was also procured from Oak Ridge.

It is probable that the questions concerning the ZPR refer to the ZPR–VI and IX blanket for which procurement was initiated in November 1959. (The last procurement for ZPR–III was in 1957–58.) Bids were requested for conversion of UF_6 to metal and commercial suppliers have been selected for both conversion and fabrication steps.

In another case, that of the EBR II blanket material, an exception was made to the general policy of using commercially available facilities, based on the apparent price differential that existed.

VI. IRRADIATION SERVICES

C. of C. V: "Preference should be accorded private irradiation facilities in place of the current preference for loading Government facilities first. This is the best way of encouraging more private capacity. Underloaded commercial facilities exist whereas it is our impression that the Government owned facilities are heavily loaded. AEC's practice of offering space in the Government owned

MTR and ETR should be limited to only those specific cases where private facilities are unavailable.

NAM–B: "The AEC should announce a policy to utilize privately owned reactors for materials testing to the extent that industry is able to provide space. This use of private reactors should be in preference to the use of a similar Government-owned facility. The current use of MTR and ETR for Government-sponsored research, which constitutes the great majority of the materials testing business, results in severe competition for the private test reactors."

Negotiations currently are underway to determine the extent to which irradiation services required for Commission programs can be obtained from either the Westinghouse or General Electric test reactors. As announced last summer, negotiations are also being conducted with the Babcock & Wilcox Co. for the construction of an additional test reactor. Irradiations will be continued at Commission test reactors depending upon the type of irradiation required and the cost of outside service.

VII. CHEMICAL PROCESSING

Cold uranium scrap

C. of C. VI–7: "Chemical processing of cold industrial scrap."

MCA–16: "Recovery of cold fabrication scrap, both high and low enriched, from all of the above projects."

In early 1959, AEC took the initial steps to acquire more scrap recovery services from industry. In March 1959, AEC began to send bid invitations to commercial scrap recovery firms to provide this service. On November 4, 1959, AEC assigned the responsibility for developing the domestic unirradiated uranium scrap industry to New York Operations Office. That office is acting as a central point for the AEC and its contractors for the placement and administration of contracts for commercial recovery of uranium scrap generated under the reactor development program. From March through November 1959 approximately 11 awards were made aggregating 344 kilograms of uranium with a total of $180,200 for recovery charges.

The New York Operations Office is currently establishing a system whereby the scrap available for commercial recovery will be reported by other offices and invitations for bids will be solicited from private firms. As a result of these steps it is expected that the commercial recovery of cold scrap will grow substantially in the future.

Irradiated fuel elements

C. of C. VII: "It is recognized that the reprocessing of irradiated fuel elements represents an area that is difficult to assess commercially. However, there is no reason to believe that many chemical firms could not handle the job if pricing, regulatory, and load problems could be successfully met. While the Government is spending large sums on developing new processes which inhibit industrial investment in known processes it can speed the transition toward a desirable commercial mode of operation by making maximum use of industrial firms in research and development and possibly the construction and operation of reprocessing plants."

NAM A–3: "In the area of reprocessing of irradiated fuel elements, the Government can and should greatly aid in the transition to a commercial mode of operation by making maximum use of industrial groups in process research and development and in construction of, and operations related to, reprocessing plants. To promote the growth of a healthy industry in this area, Government funds should be used to finance research and development programs in privately owned facilities in preference to Government-owned facilities."

The Commission has made a continuing effort to bring private industry into the field of chemical reprocessing of irradiated fuel elements. At the present time, a group of five electric utilities and a chemical company are studying the technical and economic feasibility of the design, construction, and operation of a privately owned facility for the processing of spent nuclear fuels. This study will take approximately 6 months, at the end of which time it is expected that industry will have a much clearer view as to the potential in this field. The study has the full support of the AEC. Other groups making similar studies would have the same AEC support.

Since there are a number of approaches to the problem of private operation in this field, and technology must be developed in order to find a satisfactory solution to the general problem, development programs must proceed consistent

with the objective of obtaining economic nuclear power. AEC believes that the absence of adequate technology necessitates the continuation of its programs.

Although to our knowledge there are no facilities outside of AEC capable of undertaking major development programs on recovery of spent fuel elements, AEC is prepared to receive proposals for research and development to improve fuel recovery technology.

VIII. INSTRUMENT DEVELOPMENT AND MANUFACTURING

C. of C. II–10: "Oak Ridge National Laboratory's Instrument Development Section which in some instances is working on the development of instruments in competition with commercially available equipment."

C. of C. II–12. "Each of the major Government projects have developed their own, and different: hand and foot monitors, scalers, survey meters, and multichannel radiation analyzers in competition with commercially available equipment."

C. of C. VI–6: "Instrument production work at Los Alamos, Oak Ridge, and the University of California (Berkeley)."

NAM C1g: "Personnel radiation monitors are developed and produced in instrument-production sections at Government-owned laboratories. There is an instrument industry capable of furnish of furnishing such monitors and it should be used."

NAM C1h: "Government construction of radiation measuring equipment is also in direct competition with the private instrument industry."

It is the express policy of all of the laboratories to procure instruments which are available commercially rather than to fabricate them. A survey of all laboratories and industrial establishments made in 1954 showed that over 80 percent of radiation instruments of all types were procured from private industry. A more recent survey indicates this percentage ranges from 90 to 100 percent, depending upon the mission of the facility.

It is true that some instrument-development work is continuing at major laboratories. Such work is necessary for the following reasons:

(*a*) To modify or create instruments to meet the specific requirements of a research project where the time and engineering effort necessary to prepare specifications, issue bids, instruct outside personnel, inspect for precision, and return for corrections, make outside procurement impractical.

(*b*) To develop designs in instances where commercially available instruments have proven unsatisfactory in performance and private companies have not improved their products on their own initiative but will adopt laboratory-developed designs.

While it may appear that each laboratory develops its own instruments, our survey indicates that such development is undertaken only when necessary to meet a particular condition for which a commercially available instrument is not adaptable. The facts in respect to specific instruments are—

(*a*) *Hand and foot monitors.*—Obtain commercially. Developed initially by the laboratories. One laboratory has recently developed an improved design for greater reliability.

(*b*) *Scalers.*—Such instruments typically must be modified to meet specific needs. The laboratories use commercial subassemblies.

(*c*) *Survey meters.*—While these meters are purchased from private industry, the laboratories have had to undertake development of more reliable designs in the absence of such development by industry.

(*d*) *Multichannel analyzers.*—To our knowledge, the only development work on these devices is that necessary to achieve devices for special applications. As an example, one laboratory assembled one such device in calendar year 1959 at a cost of $12,000, while in the same year it procured $192,000 worth of such devices commercially.

IX. PRODUCTION OF RADIOISOTOPES

Cobalt 60 for the High Intensity Radiation Development Laboratory

C. of C. VI–4: "Supply and/or fabrication of high purity cobalt for the High Intensity Radiation Development Laboratory at the Brookhaven National Laboratory."

MCA–10: "Supply and/or fabrication of high purity cobalt for the High Intensity Radiation Development Laboratory at the Brookhaven National Laboratory."

NAM C1c: "Supply of high purity cobalt for High Intensity Radiation Development Laboratory, Brookhaven."

The high purity cobalt in the form of nickel-plated targets for the Brookhaven radiation development facility was furnished commercially. All such cobalt is and has been supplied by commercial vendors to AEC. The canning of the cobalt for use in a reactor is controlled by the reactor operator to insure the safety and integrity of all material inserted into the reactor. Approximately 500,000 curies of cobalt 60 are needed for the Brookhaven National Laboratory program and are being produced in the engineering test reactor. At the time the radiation was begun no commercial sources of cobalt 60 existed.

Production of certain radioisotopes

C. of C. IV: "The Government is currently producing certain radioactive isotopes in a commercial way (e.g. cobalt, 60; iodine, 13; carbon, 14; sulfur, 35; phosphorus, 32). The demand for these radioactive isotopes is now at a level which makes commercial production feasible and commercial facilities exist which should be utilized."

C. of C. VI–8: "Supplying AEC's needs for * * * high purity cobalt and radioisotopes."

AEC's needs for radioisotopes are small in relation to AEC sales to others, representing 14 percent of the dollar sales. Until such time as commercial producers can supply the requirements, AEC production of radioisotopes will be necessary to meet all or part of its own needs. Commercial production of radioisotopes is small at the present time, except for cobalt 60.

The Government is producing some, but not all, radioisotopes in a commercial way. In 1955 AEC discontinued the production of cyclotron-produced radioisotopes because commercial sources were in a position to produce and market these products at reasonable prices. Also, many of the radioisotopes currently distributed by AEC are produced on a laboratory or semiworks scale because of the small demand, principally for research and developmental uses.

The AEC has never competed with the pharmaceutical industry in the manufacture and distribution of pharmaceuticals containing radioisotopes. The AEC has also turned over to private industry the following related services:

(*a*) Synthesis and marketing of C–14 labeled organics.
(*b*) Cobalt 60 encapsulation services.
(*c*) Cobalt 60 gamma irradiation services.

The foregoing demonstrates the way AEC policy has been carried out when private industry is ready to produce or perform services at reasonable prices.

The statement is made that the demand for certain radioisotopes is now at a level which makes commercial production feasible. The five leading revenue producers are:

Fiscal year 1959 sales [1]

[In thousands]

Cobalt 60	$659
Iodine 131	325
Phosphorus 32	171
Polonium 210	208
Carbon 14	263
Total	1,626

[1] Includes research discounts of about $207,000 granted to users under the AEC radioisotopes research support program.

These five radioisotopes represented 65 percent of AEC's dollar sales. All except cobalt 60 require radiochemical processing, with attendant high investment in plant facilities. Indications until recently have been that the volume of sales is not sufficient to attract private capital. In fact, the Commission has cooperated with a number of private companies who have made very detailed examinations of AEC isotope production activities and the commercial opportunities for undertaking the total isotope program. These private groups did not find the market to be sufficiently attractive for a commercial venture involving the total program. It has only been within the last few months that the Commission has received concrete evidence of private interest and intention to

produce isotopes. We understand that two existing commercial test reactors are irradiating cobalt, and that one commercial company is considering production and distribution of iodine 131 to be produced in another company's irradiation facilities. Power-reactor operators have thus far indicated no interest in producing radioisotopes.

The nature and extent of private interest in the production of cobalt 60 is being explored. Industry plans will be taken into consideration in determining the Commission's future plans to meet requirements, particularly for megacurie sources. One of the objectives of AEC is to develop large-scale uses for radioisotopes. Success in this objective is dependent on solving technical problems, achieving large-scale availability, and lowering prices. When this objective is reached, the demand for radioisotopes should be at a high enough level to attract private capital and make commercial production of a wider variety of radioisotopes economically feasible.

X. MISCELLANEOUS SERVICES

Film badge processing

C of C VI–5: "Servicing of film badges by AEC contractors."

NAM Clf: "Furnishing of film badge service for personnel monitoring. Although a number of industrial firms offer this service, competing services are performed at Oak Ridge, Brookhaven, Savannah River, Sandia, etc."

Servicing of film badges at most AEC installations is regarded as an integral part of the operating procedures established to protect the health and safety of employees. The processing and reading of film badges is intimately related to interpretation and other steps in a monitoring system. Wherever radiation exposure could reach dangerous levels or where personnel must work in radiation zones, quick detection and rapid estimation of exposure are needed for both personnel protection and control of operations; any time delay involved in relying on a commercial contractor to provide these services is unacceptable.

One AEC contractor engaged in the processing of unirradiated source materials is understood to be considering the use of commercial film badge servicing. Another, responsible for operation of an AEC laboratory, is giving serious consideration to canceling its commercial contract in favor of a return to doing its own film badge work because of several years of unsatisfactory experience with inaccuracies and errors on the part of two commercial contractors.

Printing

C of C VI–9: "Printing facilities at Government facilities."

Except for the printing establishment maintained for the production and dissemination of scientific and technical reports by the Technical Information Services Extension at Oak Ridge, AEC printing facilities are an integral part of the administrative support for routine management and operation at each AEC installation. Day-to-day operational needs are characterized by large numbers of short production runs with short leadtime.

Provisions of printing equipment for an AEC installation requires prior authorization by the Congressional Joint Committee on Printing, which periodically reviews production reports to assure that equipment continues to be needed. Typically, AEC installations procure from commercial sources a large volume of unclassified printing when large production runs are involved and lead time permits.

Transportation

C of C VI–10: "Operation and maintenance of automotive equipment and transportation facilities (bus and rail) at Government installations."

In the provision of automobile service at AEC installations, our contractors operate fleets of Government-owned vehicles of varied types. Where available, vehicles are obtained from Government motor pools. Peak loads are also met by renting equipment. Automobile service at most AEC installations is an integral supporting activity which can be provided most efficiently by the operating contractor rather than an outside commercial source.

At AEC installations which are in relatively isolated or rural locations, servicing and maintenance of motor vehicles are generally performed in AEC repair shops. There are, however, many locations where reliance on commercial shops and facilities is the practice because it has been found to be practical and more economical.

Bus transportation is provided by our operating contractors at some major AEC installations. Because of the isolation of these facilities, experience demon-

strates that commercial bus service cannot be provided on a paying basis, and operating conditions make it impractical to contract for such services at a reasonable cost.

Intraplant railroad service is performed at several installations by AEC operating contractor. At Oak Ridge prior to 1956, the plant railroad was operated under contract by one of the major railroad companies. Cost studies prompted the AEC to transfer responsibility for maintenance and operation of the plant railroad to its operating contractor. Since 1956 the estimated cost has been less than one-third of the minimum amount payable under the earlier contract with the railroad company.

In general, intermittent low-volume operations within our plant sites, often involving special equipment and handling, are best performed as a part of the integrated responsibility of the plant operating contractor.

Power distribution

C of C VI–11: "Power distribution in connection with Government installations."

Electric power distribution systems at AEC installations are operated in accordance with the normal industrial practice under which the consumer owns and operates the distribution system beyond the point of delivery, usually the high side of the initial stepdown transformer.

Generally, responsibility for the distribution of electric power within an AEC installation is such an integral part of the overall responsibility of the operating contractor for carrying out the principal mission of the installation that a separate contract for power distribution services could not be tolerated.

A special situation exists at Los Alamos, where many private residences are served from the distribution system. The feasibility of eventually disposing of that part of the distribution system which serves the town facilities is now being studied.

Communication

C of C VI–12: "Communications systems at Government installations."

Telephone, teletype, and radio communication equipment is regularly used by AEC installations. Only recently has it become possible to obtain radio equipment on a lease-maintenance basis from commercial sources, and substantial quantities of radio equipment are being secured under such arrangements.

Essentially all teletype facilities used by the AEC are leased from public utilities such as American Telephone & Telegraph Co., Western Union Co., and Radio Corp. of America. Teletype traffic of AEC is processed over networks and tielines provided by public utilities as well as over the military and other Government networks.

Nearly all AEC telephone service is provided by public utilities such as the American Telephone & Telegraph Co., Bell Telephone companies, and independent telephone companies.

The notable exception is at Hanford, where during World War II a Government-owned telephone system was built because the local telephone company could not undertake to serve so large a site. Major portions of the Hanford system, serving the business and residential areas, were sold to a public utility. Those portions directly and exclusively serving the Hanford plant areas are still owned by AEC and operated by the AEC prime contractor.

Previous analyses have indicated that the present arrangement is more economical than would be the purchase of the service from a telephone company under the rates established for that geographical area. Further studies will be made.

Machine shop facilities

C of C VI–13: "Machine shop facilities at the Argonne National Laboratory."

Machine shop jobs are performed in the Argonne National Laboratory's own central shops when (1) there is urgency to complete the job, (2) private companies are not able to perform the work, and (3) shop fabrication must be carried out coincident with design, development, and proof testing of the apparatus being built. When these factors are not present, it is the policy of the laboratory to order the work from private enterprise.

Over recent years steps have been taken to develop commercial sources for metal fabrication having the qualifications and experience to perform the type of work generated by the laboratory. A large number of qualified companies is now available.

CHAMBER OF COMMERCE OF THE UNITED STATES OF AMERICA,
Washington, February 25, 1960.

HON. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Senate Office Building,
Washington, D. C.

DEAR SENATOR ANDERSON: The Chamber of Commerce of the United States' 1960 legislative program in the field of atomic energy is attached. This is the statement I mentioned in my January 29, 1960 letter.

The statement was drafted by our committee on commercial uses of atomic energy and approved by the national chamber's board of directors on February 13, 1960.

The chamber is convinced that the principles set forth in the attached go a long way toward fulfilling the objective of the Atomic Energy Act of 1954 to "strengthen free competition in private enterprise."

I should like to stress several points in our program. Points 1, 2, and 3 are designed to increase private industry's role in the Government's atomic energy program. We applaud the Joint Committee on Atomic Energy and the Atomic Energy Commission for the many efforts to make greater use of existing and expanding industrial capacity and technical skills. Our sole purpose is to further the progress already made.

There seems to us to be a need for a clear, written statement of the Commission's policy on procurement from private facilities backed by specific instructions of implementation to all Government-owned atomic energy installations and an appropriate followup procedure. This, we would hope, could result in more uniform application of the Commission's policy which in turn will be of great help to a young industry trying to plan its future.

We do not wish the closure of Government laboratories, but rather the transferring out of the laboratories of work which can be done with reasonable efficiency in privately owned facilities so that the laboratories may concentrate on their proper and all-important function of frontier research.

Point 4, of the attached program, summarizes a longstanding chamber policy on atomic electric power which reads in part as follows:

"The Federal Government should not own or operate atomic powerplants for commercial energy production. Aside from regulation, Government activity in the area of atomic power generation should be limited to research, development, experimentation, and the encouragement of wide industrial participation. As soon as the stated purpose of any Government experimental facility has been achieved, it should be disposed of. Should any governmental experimental facility have a residual economically feasible use, it should be offered for sale. The production for sale to the public of electricity generated by means of atomic power should be the responsibility of the existing utility industry. Any interim production of atomic energy by experimental facilities at Federal Government atomic energy installations should either be used by the Government in the operation of such installations or disposed of on a nonexclusive basis to distributing utilities in the area without preference or discrimination."

To assure maximum utilization of individual creative ability, normal patent rights (as established by the patent statutes of the United States) should be applied to all inventions relating to atomic energy. Normal patent rights should be applied regardless of whether the inventions were a result of Government contracts and subject only to a royalty-free, nonexclusive license for Government use of patents developed as a result of Government contracts.

Pending restoration of normal patent rights (point 6 of the attached program) American industry should be permitted to obtain adequate patent protection in foreign countries. For this purpose, government contractual relationships should permit private contractors to take the initiative in establishing appropriate foreign patent rights in their inventions.

We appreciate this opportunity to explain the national chamber's views on what is needed to encourage the "development, growth, and state of the atomic energy industry" and would like this letter and the attached statement included in the record of the Joint Committee's section 202 hearings.

Cordially yours,

CLARENCE R. MILES,
Manager, Legislative Department.

1960 LEGISLATIVE PROGRAM IN THE FIELD OF ATOMIC ENERGY

Congress should enact legislation in the atomic field which, while implementing both domestic and international objectives, does so by strengthening our domestic enterprise system.

Specifically in dealing with atomic energy legislation Congress should incorporate the following principles:

1. Enact policies and programs designed to make maximum use of the Nation's free enterprise system.
2. Eliminate Government competition with private industry.
3. Examine and define the role of Government-owned installations with specific attention to effecting transfer of functions to privately owned installations wherever feasible as intended by the Atomic Energy Act of 1954.
4. Make certain that the Federal Government does not own or operate atomic powerplants or other facilities for commercial purposes.
5. Insist that the Government make public all information as to the full financial assistance provided for any commercial atomic program in which it participates.
6. Restore normal patent rights in the field of atomic energy.
7. Eliminate unnecessary secrecy which hampers the development of private industry in the atomic energy field.

MARCH 1, 1960.

Senator CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States,
Washington, D.C.

DEAR SENATOR ANDERSON: The Nuclear Energy Committee of the National Association of Manufacturers is pleased to submit this statement in connection with the hearings on the development, growth, and state of the atomic energy industry. We should like to comment on competition between the Government and private industry as defined in the Bureau of the Budget Bulletin 60–2.

As I am sure you know, a special task force of our nuclear energy committee reviewed activities in the nuclear energy field as they might come within the scope of this Bulletin 60–2. The results of this review were furnished to the AEC in a letter dated December 4, 1959 from the then chairman of the NAM committee, Mr. J. F. Fairman.

Without attempting to discuss in detail the areas covered in that letter, they generally fell into the category of the fuel cycle (with the exception of the U^{235} enrichment process), irradiation services, supply of special materials and services. Our task force had determined that an industrial capability exists in all of these areas and should, in our opinion, be utilized in preference to Government-owned facilities.

We recognize that this problem of competition is a complicated one, which will not be solved quickly or easily. It obviously was necessary to operate the Government-owned laboratories during the war for the military program. Further, we certainly agree that the so-called multiprogram laboratories of the Commission are still absolutely necessary today in research and development programs in the nuclear field.

However, in this rapidly changing field, private industrial capacity has grown rapidly in the past 5 years, particularly in the areas mentioned above. At the same time, the Government-owned laboratories have also grown both in total expenditures, and in the number of employees. As these operations have increased, their scope has been broadened considerably from the original research and development objectives.

It is our fundamental belief that in the area of civilian programs, Government-owned facilities should be used only for research and development activities requiring special facilities which do not exist in industry. Other activities should, insofar as possible, be carried on by privately owned facilities, financed with private funds.

Since the Atomic Energy Act of 1954 specifies that one of the objectives of national policy is "to strengthen free competition in private enterprise," we recommend a clear restatement of this policy, particularly as it pertains to the use of Government-owned facilities.

We would also recommend that a mechanism be established to give a continuing review and discussion between industry and the AEC of current programs

which are competitive, as well as future ones which might result in competition. As I have said before, it is our feeling that the programs of Government laboratories should be limited to research and development, and even there such programs should not compete with industry. The integrated activities of these laboratories which involve routine production programs should be curtailed, with the aim of cessation at the earliest practicable date.

Programs which have been advanced in the national laboratories to full-scale development status, and are nearing manufacturing stages, should then be considered for production by private industrial facilities, even though these procedures may result in a temporary increase in time schedules or cost of initial production. Changeovers are simpler at this point and will be cheaper in the long run.

It is our feeling that worthwhile results have been brought about by issuance and consideration of Bureau of the Budget Bulletin 60–2, and we look forward to future discussions with the AEC in this area. We hope that the Joint Committee will actively encourage this spirit of cooperation which will lead to maximum contribution to the peaceful development of atomic energy.

Sincerely yours,

LAUCHLIN M. CURRIE,
Chairman, Nuclear Energy Committee.

Mr. JENSEN. That is all.

COMPARISON OF POWER OUTPUT, UNITED STATES, BRITAIN, AND RUSSIA

Mr. PILLION. Mr. Chairman, may I clarify a point? Chairman McCone, with respect to the New York Herald Tribune item, evidently coming from London, the statement was made that the United States was running a poor third in the production of power by atomic energy, and that the United Kingdom had under construction a total of 1.4 million kilowatts' capacity and Russia had about the same, and the United States had about 90,000 kilowatts' capacity. Are those facts correct, and is the conclusion drawn that we are running a poor third in this power output? Is that a conclusion which is valid, Mr. Chairman? Would you care to comment about that?

Mr. MCCONE. Yes; I am glad to comment on that, because I think that we have to consider this matter from two standpoints. One is nuclear power technology and the other is production of kilowatts. The first is to what extent you are advancing, to what extent you know and are developing a foundation in this business, and the other is the extent to which you are proceeding on perhaps a relatively narrow and perhaps unsophisticated course in order to meet a particular economic requirement of the area involved. With respect to the technological knowhow in this field, I am satisfied that the United States is first, and is well ahead of any other country. I think we know more about this business than Britain or Russia, and I think that we are going to stay there. I think we have better facilities for developing this technology and I think we are proceeding on an adequate front, exploring several types of reactors which will meet our particular requirement and also will serve our international interest.

Mr. PILLION. In other words, the kilowatt capacity of production is not the true gage of the state of advancement, state of knowledge, or the technology that we have with respect to the production of power by nuclear energy, is that right?

Mr. MCCONE. That is correct. Now, the figure of 1,400,000 kilowatts in Britain is undoubtedly correct, and that figure will go up because, as this committee knows, they had a program originally of 5 or 6 million kilowatts and I think they have cut that back somewhat

and stretched it out, but nevertheless they have built that way because it serves their economic need.

With respect to Russia, they originally announced a program for about 2½ million kilowatts. They have cut that back very substantially.

Mr. CANNON. They have cut it back?

Mr. MCCONE. They have cut it back very substantially.

Running over the plants they have under construction now and for completion in late 1961 or perhaps early 1962, one boiling water reactor plant which was originally designed for 400,000 kilowatts in four separate reactors housed in one building. They have decided to build only one of those, but to provide the building space so that if that one is successful, they can then add additional units at a later date.

They are building in the Urals a pressurized water plant which originally was to be 400,000 kilowatts in two reactors. They have cut one of those out and are building to house the two of them, but only one reactor is being built.

The third plant was to go in the vicinity of Leningrad which would be a four or five hundred thousand kilowatt plant, either boiling or pressurized water. They have postponed that indefinitely, awaiting the completion and successful operation of the plant in the Urals of which I have been speaking.

Now, in another area, in a place called Ulyinsk on the river they plan to build four reactors of about 50 megawatt electrical, of differing types, for demonstration purposes and to prove out various concepts.

This then gives them six reactor concepts that they have under construction, and these four plants will be completed in 1962 and 1963. In addition, they have one operating dual purpose plant which is primarily for the production of plutonium, but does produce electricity besides, and they may have more of those, and we do not know that because that is part of their military program. The one plant that we do know about was shown at Geneva in 1958. Mr. Khrushchev, when he was here, told President Eisenhower and Professor Emelyanov told me, both here and in Russia, that they had cut back their program, that they had found that it was excessively expensive, they had encountered technical problems, and for that reason they were proceeding on a much more deliberate schedule than they had originally planned.

Mr. PILLION. Are any of the reactor technology or research involved in the production of the Soviet more advanced than ours in any respect, Mr. Chairman?

Mr. MCCONE. In some regards they have made progress in advance of us. Of course, in the field, at this time, as you say, there are any number of concepts. If one country chooses to emphasize one concept and the other does not, they would make more progress in that concept.

Mr. PILLION. But their costs are altogether different from ours. They can spend any amount of money without the accounting that we have.

Mr. MCCONE. They seem to be complaining about the cost. It seems to be a new phase in their life, it seems to me. Nevertheless, to answer your question, they have developed in their laboratory at Odninsk a

superheat coil that they have in the graphite moderated boiling water reactor which is quite advanced and it looks good to us, and we understand they are building it in one of the plants in the Urals.

In addition, they have a small experimental reactor in which they are burning plutonium, a fast reactor; that is something which we have not done as yet. They are doing it. We thought in those two respects they were surprisingly far advanced.

I might say, Mr. Chairman, if I can, that the General Manager has just handed me a note saying that the Dresden plant, which is the plant Mr. Jensen was speaking of, which is in Illinois, attained an operating level of 90,000 kilowatts today, and that I think is the highest level of production of any nuclear plant in the world.

COOPERATIVE POWER DEMONSTRATION PROGRAM

Mr. PILLION. Mr. Chairman, on page 19 of your statement you talked about a large-scale nuclear powerplant that can be undertaken by a utility company on the basis that the plant's useful life will be more economical than the powerplant using conventional fuel.

Now, how large a plant are you talking about when you talk about a large-scale nuclear powerplant?

Mr. MCCONE. 300,000 to 350,000 kilowatts.

Mr. PILLION. Further on in your statement you say, "It is possible that during the coming year the Commission may find it appropriate to encourage one or more utility companies to undertake the commitments involved in building such a large-scale nuclear powerplant."

Do you contemplate assisting the utility companies to construct a plant this coming year?

Mr. MCCONE. We are encouraging the construction of two large plants in California, one that would be a pressurized waterplant.

Mr. CANNON. What is meant by encouragement? Does that mean you are financing it?

Mr. MCCONE. No; we are encouraging them in this way. We have said that if they decide to go ahead and build the plant, put the money in it, and there is some research and development money required, we will seek authority from the Congress to support that research and development effort.

We also have said that if in their opinion they want a waiver of fuel charges for a period of years as provided under the law, we would seek authority from the Congress to grant such a waiver of fuel charges.

Mr. PILLION. Off the record.

(Discussion off the record.)

Mr. MCCONE. California comes up because this happens to be a relatively high cost fuel area. Unquestionably it was brought to the attention of some of you that California power interests are seeking authority from the Federal Power Commission to pipe gas down from Alberta, Canada, to San Francisco city gates for power purposes to meet their fuel needs, and this is quite expensive gas when they amortize the pipeline and the investment that goes in it and so forth. In the southern part of the United States there is more and more gas being purchased in the Texas field and piped to California. So California is beginning to become a have-not area from the fuel stand-

point. That is why that State comes so predominantly in the thinking at this present time.

Mr. PILLION. If you read some of the figures on the development of hydropower in that area, you would realize that there is an awful lot of money goes into hydropower there. But thank you very much, Mr. Chairman.

Mr. CANNON. Off the record.

(Discussion off the record.)

RAW MATERIALS PROGRAM

Mr. CANNON. Taking up the budget, you are requesting $630 million for the raw materials program. We shall insert in the record pages 14 through 31 of the justification.

RAW MATERIALS PROGRAM—OPERATING COSTS

Program statement

Estimate fiscal year 1961	$630,000,000
Estimate fiscal year 1960	728,646,000
Decrease	98,646,000

Uranium concentrate procurement in fiscal year 1961 is estimated at 31,823 tons compared with estimated fiscal year 1960 procurement of 35,304 tons. Uranium concentrate costs, budgeted in the amount of $619.9 million for fiscal year 1961, comprise 98 percent of total program costs. The average price per pound of $9.77 estimated for fiscal year 1961 is moderately lower than the estimated $10.09 for fiscal year 1960.

The total budgeted tonnage of uranium concentrates in fiscal year 1961 of 31,823 tons represents a decrease of 3,481 from the estimated receipts of 35,304 tons in fiscal year 1960. This decrease of 9.9 percent is expected to result mainly from domestic and Canadian deferrals. In the case of domestic production, it is estimated that some 1,300 tons previously scheduled for delivery in fiscal year 1961 will be deferred until after fiscal year 1962. The estimate of Canadian receipts in fiscal year 1961 is based on the deferral until later years of some 4,900 tons previously scheduled for delivery in fiscal year 1961. Although the greater portion of the total cost of $630 million budgeted for the raw materials program in fiscal year 1961 will be incurred for uranium concentrate procurement, funds will also be needed for a limited resource evaluation program, the procurement of uranium ores, and other special materials. The Commission will continue to acquire at published prices limited quantities of domestic uranium ores which meet specifications.

The resource evaluation program supports the uranium procurement program and is budgeted at $1,768,000 in fiscal year 1961. The principal element of the domestic program is the appraisal of privately developed uranium ore reserves in order to determine their eligibility under publicly announced programs. The foreign program provides technical guidance to foreign countries in their uranium resource evaluation.

The breakdown of the estimate by category and the explanations thereof follow:

Summary of estimates by category

	Fiscal year 1959, actual	Fiscal year 1960, estimate	Fiscal year 1961, estimate
1. Resource evaluation	$1,968,596	$1,980,000	$1,768,000
2. Procurement of source materials	703,290,329	726,307,000	628,182,000
3. Process development	275,794	309,000	0
4. Equipment not included in construction projects	(22,575)	50,000	50,000
Total, raw materials program	705,512,144	728,646,000	630,000,000

1. Resource evaluation, $1,768,000

(*a*) Domestic:

Fiscal year 1959	$1,780,918
Fiscal year 1960	1,784,000
Fiscal year 1961	1,572,000

The major items of work carried out under this activity are (1) the determination of ore reserves eligible for production of uranium concentrate under the November 24, 1958, announcement, which limited the domestic uranium procurement to production from ore reserves developed by that date; and (2) the continuing evaluation of potential resources based upon private exploration and development. This information on ore reserves is essential to the administration of outstanding contracts, to the negotiation of contract amendments and new contracts, and to the planning of current and future production schedules and capabilities.

(*b*) Foreign:

Fiscal year 1959	$187,678
Fiscal year 1960	196,000
Fiscal year 1961	196,000

Fiscal year 1961 costs provide for the salaries, quarters, and other allowances, travel and other costs of technical personnel participating in cooperative uranium evaluation programs in a number of foreign countries. In fiscal year 1961, it is expected that personnel will be stationed in Brazil, Chile, and Peru but may make brief visits to other friendly nations throughout the world.

2. Procurement of source materials, $628,182,000

(*a*) Uranium concentrates and oxides:

Fiscal year 1959	$676,554,686
Fiscal year 1960	708,963,000
Fiscal year 1961	619,865,000

Procurement of uranium concentrates is required for production of special nuclear materials for military and peaceful uses of atomic energy. The estimate for such procurement provides for the deliveries to the Commission of uranium concentrates from the principal sources represented by contracts with (1) individual private processing mill operators in the United States; (2) the Canadian Government; and (3) the South African government (through the Combined Development Agency). The uranium concentrates to be supplied to the Commission in fiscal year 1961 total 31,823 tons as compared with 35,304 tons to be supplied in fiscal year 1960—a reduction of 3,481 tons. The breakdown of procurement by sources is set forth in the following tabulation:

	Fiscal year 1959			Fiscal year 1960			Fiscal year 1961		
	Tons U^{308}	Unit price (per pound)	Cost (in thousands)	Tons U^{308}	Unit price (per pound)	Cost (in thousands)	Tons U^{308}	Unit price (per pound)	Cost (in thousands)
United States	15,162	$9.26	$280,701	17,174	$8.76	$300,813	18,433	$8.57	$316,075
Canada	13,506	10.87	293,619	13,550	11.12	301,377	9,000	11.08	1 9 402
Overseas	4,658	11.84	110,299	4,580	12.04	110,274	4,390	12.10	106,238
Total uranium concentrates	33,326	10.27	684,619	35,304	10.09	712,464	31,823	9.77	621,715
Add: Refining costs (Canada and Belgian Congo, upgrading U^{308} to U^{03})			6,288			3,217			2,870
Deduct:									
Usage of uranium ores			3,124			1,149			0
Sale of uranium ores to processing mills			11,228			5,569			4,720
Total, uranium concentrates, net			676,555			708,963			619,865

All concentrate procurement contracts provide for a specified total tonnage to be delivered to the Commission during the contract period. Delivery of the

total commitment under each contract is regulated in the majority of domestic contracts either by limiting the quantity of uranium ores that may be fed to process during each 3-month period throughout the period of the contract, or by limiting the quantity of uranium concentrates which the Commission is required to purchase annually. The contract with the Canadian Government provides for a specified maximum tonnage to be delivered annually. By agreement in May 1958, a ceiling was also placed on annual South African deliveries effective with July 1959 deliveries.

Since deliveries of concentrates under present contracts would be in excess of the currently forecast needs for fiscal year 1961 and fiscal year 1962, steps have been taken to reduce deliveries during this period. Negotiations have been initiated by the Commission with domestic concentrate producers and by the Canadian Government with the Canadian uranium industry to provide for contract revisions which would extend their present completion dates and would defer deliveries presently scheduled for fiscal years 1960, 1961, and 1962 until the 1962 to 1966 period.

Based on discussions with domestic contractors to date, it is estimated that a maximum of 1,300 tons of uranium concentrates which otherwise could have been delivered during fiscal year 1961 can be deferred until after fiscal year 1962. The present estimate of the effect of the negotiations between the Canadian Government and its primary suppliers on the fiscal year 1961 deliveries of uranium by the Canadian Government is a reduction of some 4,900 tons which otherwise would have been provided under contract. It should be noted that for both domestic and Canadian estimates, the deferrals anticipated are based on preliminary negotiations. To the extent that the full deferral is not realized, additional amounts may be required to fund deliveries under this program.

The following discussion of U^{308} deliveries by major source is based on estimated total deliveries of 31,823 tons in fiscal year 1961:

United States: It is estimated that domestic receipts in fiscal year 1961 will be 18,433 tons, all but 96 tons of which is estimated to be received from 26 mills in the western United States. These 96 tons will be produced by the remaining two active contractors under the phosphate program, one of which will terminate in fiscal year 1961. The estimate of 18,337 tons from western mills is based on deliveries from current contracts, after consideration of possible deferrals, and from new contracts or contract extensions with domestic producers who qualify under the Commission's announcements of April 2 and November 24, 1958.

Canada: On November 6, 1959, the AEC announced a stretchout agreement under which the Commission's total Canadian uranium commitments remained unchanged but which would permit the deferral of a portion of the currently scheduled deliveries of uranium until the 1962–66 period.

Deliveries in fiscal year 1961 from the Canadian processing plants are estimated at approximately 34 percent less than the budgeted deliveries in fiscal year 1960. This decrease reflects the anticipated deferral to later periods of 4,900 tons of scheduled fiscal year 1961 deliveries. Contracts will be amended to provide that any deliveries deferred during fiscal year 1960, 1961, and 1962 will be delivered in years subsequent to fiscal year 1962.

Overseas: Total U^{308} procurement in fiscal year 1961 from oversea sources through the Combined Development Agency (a joint United States-United Kingdom purchasing agency) is expected to be at a slightly lower level than in fiscal year 1960. The principal producer of overseas procurement is South Africa. Additionally, the Belgian Congo, Portugal, and Australia will continue as producers in fiscal year 1961. The purchase of uranium concentrates from the Belgian Congo will be completed in fiscal year 1961.

Average prices: The average price paid for domestic uranium concentrates continues to decline, reflecting new contracts and amendments based upon the improved metallurgy and larger capacity of the new mills, despite higher labor and material costs. It will be noted that in all 3 fiscal years the average unit price paid for U.S. uranium concentrates is lower than the average price paid for concentrates from foreign sources. All foreign contracts were negotiated several years ago and contract prices reflect grade of ore to be processed, estimated operating costs and other factors. Domestic ores give an average recovery of about 5 pounds of U^{308} per ton. Canadian ores average about 2 pounds per ton, and South African ores average about one-half pound per ton. In other words, for each ton of domestic ore mined and milled, Canada must mine and mill

and average of 2½ tons and South Africa 10 tons to obtain the equivalent uranium production.

(*b*) Uranium ores:

Fiscal year 1959	$1,952,203
Fiscal year 1960	5,917,000
Fiscal year 1961	5,297,000

The Commission is committed to purchase at published prices limited quantities of domestic uranium ores which meet specifications. In addition, purchases will be necessary to provide a market for ore producers in certain areas as provided for in the April 1958 limited expansion program as an alternative to the addition of new mill facilities or expansion in concentrate production to treat these ores. The ores will be sold to milling companies after 1962. Industry is buying more than 98 percent of all uranium ores mined.

Ore procurement in the 3 fiscal years is shown in the following table:

[Thousands omitted]

	Tons ore	Price per ton	Cost
Fiscal year 1959	63,273	$30.85	$1,952
Fiscal year 1960	144,180	41.03	5,917
Fiscal year 1961	148,800	35.60	5,297

(*c*) Bonus incentive for initial production:

Fiscal year 1959	$2,307,007
Fiscal year 1960	2,500,000
Fiscal year 1961	0

The bonus incentive program terminated on March 31, 1960.

(*d*) Vanadium:

Fiscal year 1959	$3,225,923
Fiscal year 1960	505,000
Fiscal year 1961	0

Two of the Commission's domestic unit price concentrate contractors have the option of disposing of the byproduct vanadium pentoxide either on the open market or to the Commission at a fixed contractual price per pound. This contingent liability is a contractual commitment on the part of the Commission, but based on the current industrial demand it is not expected that the Commission will be required to purchase any vanadium pentoxide in either fiscal year 1960 or fiscal year 1961. However, should the industrial market fail to absorb any of the vanadium production, the Commission could be required to purchase up to 1,560 tons costing $3,072,000 in fiscal year 1961.

The estimated cost of $505,000 in fiscal year 1960 is to provide for the purchase of vanadium in mill tailings. There will, however, be no costs in fiscal year 1961 for this item inasmuch as this provision has been eliminated from all contracts.

Actual tonnage and costs in fiscal 1959 and estimates for fiscal years 1960 and 1961 follow:

	Fiscal year 1959			Fiscal year 1960			Fiscal year 1961		
	Tons	Unit price (per pound)	Cost (in thousands omitted)	Tons	Unit price (per pound)	Cost (in thousands omitted)	Tons	Unit price (per pound)	Cost (in thousands omitted)
Vanadium pentoxide	836	$1.02	$1,710	0	.....	0	0	.....	0
Vanadium tailings	2,441	.31	1,516	815	$0.31	$505	0	.....	0
Total	.....	.....	3,226	.....	.....	505	.....	.....	0

(e) Thorium:

Fiscal year 1959	$575,054
Fiscal year 1960	177,000
Fiscal year 1961	0

Deliveries under the last thorium contract were completed in December 1959. No further purchases are presently contemplated.

(f) Other special materials:

Fiscal year 1959	$18,675,456
Fiscal year 1960	8,245,000
Fiscal year 1961	3,020,000

This activity provides for the procurement of other special materials required in the Commission's production program.

Additional information of a classified nature is presented on page 22.

3. Process development, 0.

The principal process development activities carried on at the Raw Materials Development Laboratory at Winchester, Mass., were terminated at the end of fiscal year 1958, however, studies are continuing through fiscal year 1960 on the reduction or elimination of radiation hazards from uranium mills. This work includes development of more accurate and rapid analytical processing for determining the content of radioactive isotopes in mill wastes and improved methods for disposal of waste products. Related activities will be carried on under the biology and medicine program in fiscal year 1961.

The major segments of process development costs for fiscal years 1959 and 1960 are as follows:

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
Raw Materials Process Development Laboratory, National Lead Co., chemical studies	$188,666	$309,000	0
Other contractors, principally domestic ores	48,810	0	0
Shales, Columbia University	38,318	0	0
Total, process development	275,794	309,000	0

4. Equipment not included in construction projects, $50,000

Equipment for fiscal 1961 will be required principally in support of the uranium concentrate and ore purchase activities including sampling and assaying for payment purposes. Costs are estimated at $50,000 for fiscal year 1961. The following table reflects a comparison by installation of equipment costs with related other operating costs in the raw materials program.

Fiscal year 1961 costs

[In thousands]

Installation:	
Grand Junction:	
Other operating	$2,900
Equipment	50

RAW MATERIALS STOCKPILING

Mr. CANNON. Your raw materials purchases are being substantially reduced in 1961 but your special nuclear material production is at about the same level as this year, that is on a dollar basis, at least. This would seem to indicate that there has been stockpiling at some point. What is the situation?

General LUEDECKE. No, sir, we are not stockpiling.

Mr. CANNON. You are not holding anything in reserve then?

Mr. MCCONE. No, there is nothing being held in reserve. All of the uranium oxide is being processed into the finished product.

Mr. CANNON. In your resources evaluation program you indicate that you still are busy determining production eligibility under the November 24, 1958 procurement announcement. How much is allocated to this function at the present time?

Mr. JOHNSON. Practically the entire amount there is for that program.

Mr. CANNON. When will you complete it?

Mr. JOHNSON. We are still striving to complete it by the end of 1961. We must do it. We have received data from or requests or applications from 2,650 properties claiming that they have ore reserves eligible under the November 1958 announcement. Our work has not proceeded as fast as we would like. We have taken care of most of the larger properties containing the larger reserves but we have these large numbers of small operations, properties, which have to be examined, even though they have no uranium. We have a major problem to meet that deadline.

Mr. CANNON. Your foreign evaluation program continues at the same level of 196,000. Why is that necessary under the circumstances?

Mr. JOHNSON. We are terminating the three projects underway now, one in Brazil, one in Peru, and one in Chile. They have been going for some time. We have made termination arrangements during the past fiscal year working with the State Department, because there were objections by the countries involved but the projects will be closed at the end of this calendar year. This was done since our budget was fully prepared. With the program closing at the end of the calendar year, and there will be some report writing, and have the travel expense of bringing the personnel and families and possessions back to this country. I don't think there will be much of a reduction as far as the 1961 budget is concerned. It would not be significant. There may be some.

ALUMINUM PROCUREMENT

Mr. CANNON. Last year the committee directed you to work out a plan for filling your aluminum requirement from existing Government stockpiles.

To what extent have you been able to follow that direction?

General LUEDECKE. Mr. Chairman, after the hearing I got in touch with the Director of OCDM and arrangements were worked out between OCDM and the GSA to permit AEC to issue instructions to the field in October directing our operations officers as to the method of procurement of this aluminum. I informed your committee by letter on November 12, 1959 of these instructions and indicated to you that at that time we estimated our requirements for this particular material would be on the order of 5,000 pounds during 1960. Now we did have some requirements for aluminum, of approximately the DPA inventory chemical specifications, at Savannah River and Oak Ridge. Neither office was equipped to handle aluminum pigs as large as the minimum stocked in the inventory.

In the case of Oak Ridge, we have changed the furnace openings and will be able to use inventory aluminum in the future. At Savannah River, we anticipate no future requirements for inventory

specification material, as a result of changing to a process that does not require aluminum. The result is that up to now we have actually made no purchases under this authorization, but we anticipate a requirement for approximately 7,200 pounds, that is about 1,800 pounds per quarter, for the future.

Mr. CANNON. That is during this fiscal year?

General LUEDECKE. Yes, sir. During fiscal year 1961.

Mr. CANNON. One of our difficulties at the present time is that the United States has accumulated vast stockpiles of every conceivable material we might use in case of war. In the old days we always wanted to fight the next war like we fought the last war. We waited until war was declared and then, while France and England held the enemy off, we proceeded to tool up our factories and mobilize our armies and assemble our resources, and we beat the enemy both in World War I and World War II, by outproducing them. That is a thing of the past. We must fight the next war if war comes with what we have at the time. There will be no possibility of adding to it; the war will be over in a day or two. Over half of this large stockpile that has been accumulated is superfluous to even our maximum requirements. But we are having difficulty disposing of them because the commercial interests do not want them put on the market or they want to use this as a reservoir to which they can sell of their material which they develop and for which there is no immediate market or for which the market is not satisfactory. So our problem now is to get rid of it. We hoped that we could get rid of some of it here.

We have this study here, from the General Manager, and he states, for example:

> Available requirement. The requirement data covering aluminum and aluminum basal alloys indicate that the AEC program will use only 4 percent of its total 1960 requirements of approximately 16,303,000 pounds in the form of aluminum pigs or ingots. This 4 percent, or approximately 650,000 pounds—

now, that is what we have in mind, this 650,000 pounds—

> would have a dollar value of about $165,000 at current prices exclusive of transportation, handling costs, and so forth.

Why did ODM object to a plan to have contractors draw aluminum from the stockpile?

General LUEDECKE. Mr. Chairman, I am unable to answer that question this afternoon. I don't have the papers with me. I wonder if I could provide it for the record?

Mr. CANNON. You can see that it is the policy of the Congress to draw on these stockpiles wherever possible instead of going out and spending new money for supplies and leaving all this excess supply where it cannot be of any possible use. We want to get rid of it. We thought you would get rid of some of it. I am at a loss to understand why you did not use it. Will you let us know when your transcript comes back why it was not utilized and I will include these two statements here in the record at this point.

General LUEDECKE. I will do so.

(The information referred to follows:)

U.S. ATOMIC ENERGY COMMISSION,
Washington, D.C., July 8, 1959.

HON. CLARENCE CANNON,
Chairman, Committee on Appropriations,
House of Representatives.

DEAR MR. CANNON: During the course of the recently completed hearings before your committee on the Commission's fiscal year 1960 budget estimates, the Commission was requested to study the feasibility of procuring from GSA certain materials which are being stockpiled such as aluminum and copper, which are in excess of the stockpile goals, and to report back to your committee the results of this study.

In this connection GSA was contacted to ascertain in what form these excess materials were available in order to determine their suitability in meeting AEC needs. We were advised that the material in stockpile is in a fairly basic form, i.e. pigs, ingots, or their equivalent. It should be noted that AEC requirements for material in this particular form are relatively minor, the bulk of our needs being for finished fabricated or semifabricated shapes. For example, available AEC requirements data covering aluminum and aluminum-base alloys indicate that the AEC program will use only 4 percent of its total 1960 requirements of approximately 16,303,000 pounds in the form of aluminum pigs or ingots. This 4 percent or approximately 650,000 pounds would have a dollar value of about $165,000 at current prices, exclusive of transportation and handling costs. In the case of copper and copper-base alloys, the AEC requirements are almost entirely composed of various finished brass-mill and wire-mill products.

In view of the foregoing, for the Atomic Energy Commission to meet any of its materials requirements through use of excess stockpile materials, it would be necessary to make a major change in its current procurement procedures.

Generally, at present, the Commission's cost-type operating contractors go out to suppliers on a competitive-bid basis for the procurement of finished fabricated and semifabricated articles made of the materials under discussion. These suppliers of course are, in many instances, dependent upon a more primary supplier for the raw stocks, which in turn they convert into the forms called for by the AEC operating contractors in their bid invitations. Therefore, if the Commission is to use excess stockpile materials the following would be required:

(1) Proper authorization would have to be received to have excess U.S. national stockpile stocks made available to AEC. We have been advised that this requires congressional approval;

(2) The AEC would have to pay current market prices for this material;

(3) The AEC operating contractors, in their bid invitations would have to specify that the raw stocks would be Government furnished materials, and that bid amounts must be based on conversion costs only;

(4) The AEC would have to assure that the materials would get from the stockpile locations into the hands of the successful supply bidders and pay any necessary costs.

Within the limited time available, it has been possible to assess only the highlights of the problems, as outlined above, associated with the Commission utilizing excess stockpile materials. We shall be pleased to work further with your staff in detailing the administrative problems involved as well as discussing what authorizations by Congress and the executive branch would be required if such a procedure were to be placed in effect.

Sincerely yours,

(Signed) A. R. LUEDECKE,
General Manager.

U.S. ATOMIC ENERGY COMMISSION,
Washington, D.C., November 12, 1959.

HON. CLARENCE CANNON,
Chairman, Committee on Appropriations,
House of Representatives.

DEAR MR. CANNON: House Report Nos. 685 and 772, 86th Congress, 1st session, issued in connection with action on the fiscal year 1960 appropriations of the Atomic Energy Commission, directed that procedures be implemented as rapidly as possible for drawing the aluminum requirements of the AEC from the Defense

Production Act inventory administered by the General Services Administration. This is to advise you of the plan for implementation of such procedures.

The Office of Civil and Defense Mobilization, which controls the disposition of the DPA inventory, has authorized the General Services Administration to make aluminum available for direct use by AEC and the cost-type contractors that operate AEC facilities. However, this authorization precludes AEC from supplying DPA inventory aluminum pig, as Government-furnished material, to contractors or subcontractors that manufacture aluminum products. Under this authorization it is estimated that during fiscal year 1960 the Atomic Energy Commission will draw down from the Defense Production Act inventories approximately 5,000 pounds of aluminum pig suitable for AEC direct use.

AEC and GSA have developed procedures for handling orders, deliveries, and payments, in connection with AEC use of DPA inventory aluminum, and are now operating under these procedures.

Sincerely yours,

DWIGHT A. INK
(For the General Manager).

U.S. ATOMIC ENERGY COMMISSION,
Washington, D.C., April 27, 1960.

HON. CLARENCE CANNON,
Chairman, Committee on Appropriations,
House of Representatives.

DEAR MR. CANNON: During the recent hearings before your committee, regarding the Commission's 1961 budget estimates, you noted that last year the committee directed the Atomic Energy Commission to work out a plan for filling its aluminum requirements from existing Government stockpiles and you asked to what extent we had been able to follow that direction.

As I indicated to you in my letter of November 12, 1959, the authorization issued by the Office of Civil and Defense Mobilization would permit AEC and its operating contractors to withdraw aluminum from the Defense Production Act inventory for direct agency use. This precluded AEC from supplying DPA inventory aluminum pig as Government-furnished material to contractors or subcontractors that manufacture aluminum products. Most of our estimate of 650,000 pounds of aluminum pigs or ingots which were referred to were for use in AEC plants. It was found however, upon further study, that only about 5,000 pounds of our 1960 pig aluminum requirements could be met from the inventory because of the chemical specifications available in that inventory. Most of the 650,000 pounds of pig aluminum used by AEC involves: (1) 99.99 percent purity aluminum, (2) aluminum silicon alloys, (3) special aluminum alloys. Aluminum of these sepcifications is not contained in the inventory. As a result of this study, we estimated that only about 5,000 pounds of our requirements could be met from the stockpile and we set forth this estimate in our letter to you of November 12.

During the hearing, you also asked, "Why did OCDM object to a plan to have contractors draw aluminum from the stockpile?" We have been informally advised by the Office of Civil and Defense Mobilization as follows:

"The release of aluminum from the Defense Production Act inventory for direct AEC use is consistent with the Government's policy relative to the disposal of materials excess to Government needs.

"The OCDM policy statement, DMO V–7, as revised December 10, 1959, only requires that Government agencies meet their requirements for materials from excess Government inventories when they can use these materials directly and in the form and quality found in the inventories.

"The OCDM policy does not require that excess Government inventories be supplied to private, prime, or subcontractors for the performance of work for the Government. Required use of such materials in prime supply contracts, and especially in subcontracts, was considered to be inadvisable for several reasons. These reasons include:

"First, to furnish Government contractors with such material would be in effect a disposal of material, and therefore the transaction would have to meet the criteria for disposal in DMO V–7, revised. These are: (*a*) avoidance of serious disruption of the usual markets of producers, processors, and con-

sumers; (*b*) avoidance of adverse effects on international interests of the United States; (*c*) due regard to the protection of the United States against avoidable loss; and (*d*) approval of the Departments of Interior, Commerce, State, Defense, and other governmental agencies concerned and consultation as appropriate with the industries concerned.

"The more important reason, however, is that in almost all cases contractors or contractor suppliers do not use material in the pig or ingot form in which it is stockpiled.

"A large proportion of Government contracts involve a primary contractor and one or several subcontractors. To supply prime contractors and various subcontractors in the procurement line with excess Government material would involve added complications and expenses for both the Government and the contractors for administration, transportation, and processing by additional subcontractors. It would be more in the Government's interest to 'dispose' in the regular way of an equivalent amount of such material, with the Government contractor securing his material in the chemical analysis, shape, and form in which he wants to use it from his usual commercial sources.

"For the foregoing reasons, the authorization to AEC was limited to meeting the direct requirements of AEC for the grades and forms of aluminum that are in the Defense Production Act inventories."

As I indicated in my testimony, we have not to date made any withdrawals or purchased any aluminum from the DPA inventory. We have instructed our operations and operating contractor purchasing offices to draw AEC pig aluminum requirements from the DPA inventory where the required specifications can be met. We will reaffirm the instructions and emphasize that DPA inventory pig aluminum is to be used to the extent that pertinent specifications and the OCDM authorization will permit.

I trust you will find the foregoing a satisfactory answer to your inquiry.

Sincerely yours,

A. R. LUEDECKE, *General Manager.*

FIVE-YEAR COST OF RAW MATERIAL PROGRAM

Mr. CANNON. I wish you would also insert in the record a tabulation showing the budget estimate and the actual cost in the last 5 years of this entire raw materials program. We would like to see from year to year what progress you have made in this respect, and how your budget estimate compares with the actual cost.

Mr. MCCARTHY. We will insert that.

(The information follows:)

Comparison of amount available with actual cost experience

[In millions of dollars]

Raw materials	Amount available	Actual cost	Difference
Fiscal year:			
1955	206.0	191.9	−14.1
1956	318.4	281.0	−37.4
1957	407.8	397.8	−10.0
1958	599.0	598.6	−.4
1959	680.0	705.5	+25.5

SPECIAL NUCLEAR MATERIALS

Mr. CANNON. Under "Special nuclear materials" you are requesting $567,700,000, and we shall insert here pages 23 and 24.

(The justification is as follows:)

SPECIAL NUCLEAR MATERIALS PROGRAM—OPERATING COSTS

Program statement

Estimate fiscal year 1961	$567,700,000
Estimate fiscal year 1960	563,000,000
Increase	4,700,000

Summary of estimates by category

Category	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
1. Procurement and production	$503,530,919	$526,218,000	$531,968,000
2. Process development	37,772,536	36,782,000	35,732,000
Total, special nuclear materials program	541,303,455	563,000,000	567,700,000

JUSTIFICATION OF CATEGORIES

1. Procurement and production, $531,968,000

These funds provide for the operation of Government facilities for the production of special nuclear and other special materials required for use in weapons manufacture, research, and development and in the peaceful applications of atomic energy. The major units of the production complex are located at Oak Ridge, Tenn.; Paducah, Ky.; Portsmouth, Ohio; Hanford, Wash.; Savannah River, S.C.; Fernald, Ohio; and Weldon Spring, Mo. In general, there is a reduction in the unit cost of processing materials in the production chain.

2. Process development, $35,732,000

These funds provide for technical plant support assuring continuity and safety of operations, and development and improvement of processes and equipment utilized in producing and processing uranium feed materials, enriched U^{235}, plutonium and other special products. The development program also assures attainment of production levels required to meet current AEC commitments at the lowest possible cost of operation. Development effort varies at each site in accordance with the production requirements of the sites.

PROCESS DEVELOPMENT PROGRAM

Mr. CANNON. Your process development program continues at approximately the same level. What specific achievement in improving your operations has been realized since last year? This has been a year of change and I trust has been a year of progress, but what progress have you made, and what specific achievement in improving your operations?

Mr. QUINN. We have made progress, Mr. Chairman, in most of our activities. As examples, in the production of enriched uranium U^{235} account, we have capitalized on our development efforts by instituting a revision to the cascade improvement program which will utilize improved barrier in the cascades. This was a program which has been instituted within the past year.

In our feed materials area, we have capitalized on this by achieving some reduction in our unit costs.

Mr. CANNON. It appears now that you will process a lesser amount of feed materials in 1961 than in 1959 and 1960. Does this mean that

you are producing less weapons material than you are capable of producing?

(Discussion off the record.)

Mr. QUINN. Eventually as raw materials receipts become lower, there will be an impact on U^{235} output.

Mr. TABER. I thought you were reducing your intake because of quantity on hand and that therefore the cost would go down.

Mr. QUINN. The costs that are affected by the availability of natural uranium are the feed material costs. These are costs for processing the virgin uranium into UF^6, or metal, to go into our fissionable material production plants. Actually, in 1961 our feed material operations costs are lower by $3.5 million than in 1960. The costs for U^{235} are those that actually are incurred in operating the gaseous diffusion plants. These plants will continue to operate at essentially the same level as in 1960. There will be a small reduction in utilization of power.

Mr. CANNON. Are you producing at capacity? Are you turning out weapons material you are capable of producing?

Mr. QUINN. At the present time, sir, we are operating our diffusion plants with the full amount of power available under our power contracts, and we are using feed material as it becomes available in the most economical manner. We do have programed for the second half of fiscal year 1961 a small reduction in cascade power.

(Discussion off the record.)

Mr. CANNON. You have consumed less raw material.

General LUEDECKE. Yes, sir. We are buying less raw material in that year.

Mr. CANNON. Now, you are stockpiling again?

General LUEDECKE. No, sir; we are not stockpiling.

Mr. CANNON. How does it happen——

STOCKPILE OF SECONDARY URANIUM MATERIALS

Mr. QUINN. As far as utilization of the virgin uranium is concerned, there is a timelag between its purchase and its actually being fed to the gaseous diffusion plants. Some of it actually goes the route of the plutonium reactors and back to the diffusion plants where more U^{235} is separated. In addition to this primary feed material, we also have a secondary feed to the diffusion plant which consists of depleted material that has previously been processed through the diffusion plants but from which the U^{235} has not been completely stripped. During periods when we have less virgin uranium available we find it profitable to recycle these tails and this contributes to production.

Mr. CANNON. Well, your secondary feed material then is your stockpile, is it not?

Mr. QUINN. We certainly are keeping the depleted tails available for whatever use we can make of them.

Mr. CANNON. How much of it do you now have? Have you enough to operate another year?

(Discussion off the record.)

Mr. QUINN. We could operate ———. It would be more expensive material but we still——

Mr. CANNON. It would be more economical if you did not have to buy more material.

Mr. QUINN. That is right, but the further down we strip uranium, the more U^{235} we try to take out of a ton of natural uranium, the more expensive it becomes.

Mr. CANNON. Now, we are trying to get away here from a thing which I am not so certain you have convinced the committee is being obviated or eliminated. Military requirements are whatever you can produce and the more feed material you put through, the more you produce.

Mr. QUINN. More feed will result in more production, sir.

Mr. CANNON. You seem not to be putting it through at the rate that you have reached heretofore.

Mr. QUINN. We are putting it through in the manner we find most economic.

Mr. CANNON. I take for granted, then, from what you tell us, that you could operate another year on secondary material which you have in the stockpile at this time.

Mr. QUINN. We could operate ——— but with the reduced production and with higher unit cost of the production.

Mr. CANNON. Now you could operate entirely with this secondary material.

(Discussion off the record.)

Mr. CANNON. You would save money, but you would not get the results?

Mr. QUINN. We would not save money except in the purchase of natural uranium. It would cost the same amount to operate the plant. We could continue to reprocess these tails and strip them down further and further, but we would get less and less out of them each time around.

Mr. CANNON. Do you have to meet any deadline or are your requirements whatever you produce?

Mr. QUINN. We have specific schedules to meet, sir.

Mr. CANNON. Are there any questions on that?

Mr. TABER. What do you do with these tails? Are they the rag end of what you have been operating with?

Mr. QUINN. They are uranium in the form of UF_6, which is the same as the feed material to the diffusion plant, but which contains U^{235} ———.

Mr. TABER. It costs you more to process it than to buy new material?

Mr. QUINN. It is more expensive to extract U^{235} from this depleted material.

Mr. TABER. The cascade operation costs are more expensive?

Mr. QUINN. The operation is the same cost but the production rate is reduced by using the lower quality material.

Mr. TABER. That means that it costs more.

Mr. QUINN. Unit cost is higher, that is correct.

Mr. TABER. At the same time you don't have to pay for the purchase of the new uranium ore.

Mr. QUINN. We have contractual commitments for the purchase of virgin uranium, sir.

Mr. TABER. That is over quite a long period, is it not?

Mr. QUINN. Yes, sir.

Mr. TABER. How long a period?

General LUEDECKE. Until the end of calendar year 1966.

Mr. TABER. So that you have to buy that and stockpile it anyway, whether you use these tails or not.

Mr. QUINN. Yes, sir.

Mr. CANNON. Now, you say you have a schedule of production which calls for a certain amount annually. Do you also have a schedule for the rate of reduction of this secondary material or is it to continue to be added to and will it increase every year as time goes by? Do you propose to continue to build a higher and higher stockpile of secondary material?

Mr. QUINN. All the natural uranium that is fed into the production system, whether for plutonium or for U^{235}, eventually ends up in the stockpiled tails.

Mr. CANNON. Yes, and it is to our interests to get rid of it?

Mr. QUINN. We feel that it has potential value for reuse. In other words, it is possible to produce U^{235} from this material economically. It is not stripped so far that it becomes noneconomic to reprocess.

Mr. CANNON. Do you expect to accumulate it indefinitely?

Mr. QUINN. We have programs underway to find other uses for uranium, particularly this depleted material. At the present time there is no substantial requirement for uranium as a chemical element other than in our program.

Mr. CANNON. You have a definite study now in operation then to find some other——

Mr. QUINN. We have research and development going on to find uses for this uranium, that is correct.

Mr. CANNON. What is the prospect of solving that problem in the near future?

Mr. QUINN. The prospect is that it is very unlikely that uses will be found that will use a substantial quantity of it. After all, we are buying some 30,000 tons a year. We know of no large-scale use for this material other than for possible recycling.

Mr. CANNON. And is there prospect of developing a use or utilization?

Mr. QUINN. There is no prospect for that quantity. It is available today for sale to industry if they have any use for it. It may be quite valuable as a shielding material in shipping radioactive materials, for example.

Mr. CANNON. Have you notified industry that it is for sale?

Mr. QUINN. Yes, sir.

Mr. JENSEN. Have you made any sales?

Mr. QUINN. There have been some sales, small amounts.

Mr. JENSEN. What quantity?

Mr. QUINN. Mostly for nuclear uses, however.

Mr. JENSEN. In any quantity?

Mr. QUINN. I do not have the figures, but blankets for reactors for example. I think the Detroit Edison reactor in Michigan is using depleted uranium as a blanket material.

EQUIPMENT ITEM

Mr. CANNON. Your catchall equipment item here, $22,323,000, is about the same as last year. We thought that possibly as time went

by that item would be reduced. Is this like the stockpile of secondary material? Will we always have it or can we anticipate that eventually we will reduce this item?

Mr. QUINN. I think as long as we are operating our production plants there will be need for equipment.

Mr. CANNON. Of this magnitude, $22 million or $23 million?

Mr. QUINN. Yes, sir; actually the plants are getting older and it is possible that equipment requirements could increase in the future.

Mr. CANNON. Will you insert in the record a tabulation here showing the estimates and the actual costs for each of the last 5 years?

Mr. QUINN. Yes, sir.

Mr. CANNON. And will you also supply for committee use a tabulation showing the amount of uranium tails on hand at the end of each of the last 5 years? Please insert in the record a tabulation showing estimates and actual cost of each in the last 5 years of the whole program.

(The information referred to follows:)

SPECIAL NUCLEAR MATERIALS PROGRAM EQUIPMENT

Comparison of amount available with actual experience

[In thousands of dollars]

Fiscal year	Amount available	Actual cost	Difference
1955	(1)	(1)	(1)
1956	(1)	(1)	(1)
1957	$15,558	$12,779	−$2,779
1958	19,361	21,144	+1,783
1959	22,000	20,520	−1,480

[1] Prior to fiscal year 1957 equipment was budgeted by type of equipment with no program identification under "Plant acquisition and construction."

Comparison of amount available with actual cost experience

[In millions of dollars]

	Amount available	Actual cost	Difference
Special nuclear materials:			
Fiscal year:			
1955	534.1	435.0	−99.1
1956	619.1	553.1	−66.0
1957	604.8	581.6	−23.2
1958	594.3	567.7	−26.6
1959	570.0	541.3	−28.7

WEDNESDAY, APRIL 20, 1960.

WEAPONS PROGRAM

Mr. CANNON. On the weapons program we will insert page 40 and ask you to give us a tabulation showing estimates and actual costs in this program for each of the last 5 years.

(The matter referred to follows:)

WEAPONS PROGRAM—OPERATING COSTS

Program statement

Estimate fiscal year 1961	$504,000,000
Estimate fiscal year 1960	498,100,000
Increase	+5,900,000

The amount requested for fiscal year 1961 reflects the estimate of funds needed for the development, production, storage, and surveillance of atomic weapons required to meet military needs.

Atomic research has continued to yield new information applicable to development of weapons and such data will be incorporated in the design of new models which will greatly enhance the capabilities of the Armed Forces.

Comparison of amount available with actual cost experience

[In millions of dollars]

	Amount available	Actual cost	Difference
Weapons:			
Fiscal year:			
1955	320.9	238.2	−82.7
1956	271.1	257.4	−13.7
1957	299.4	323.3	+23.9
1958	452.3	433.0	−19.3
1959	541.1	487.5	−53.6

WEAPONS TESTS

Mr. CANNON. Mr. McCone, there is a reference in the last column of the editorial page of the Washington Post about the discharge of your official duties. Briefly, what are the facts?

Mr. MCCONE. The facts of the case are, sir, consistently throughout the test suspension discussions I personally and the Commission have taken the position that we genuinely support an effort to reach an agreement on test suspension providing that agreement and the areas of test which are suspended can be adequately and properly safeguarded. We have pointed out that tests below a threshold of a 4.75 intensity indication on a seismograph, cannot be safeguarded. That a country such as the Soviet Union could conduct tests under that threshold in a clandestine manner, and we would not know that such tests were being carried on.

The decision was made that in order to advance the negotiations, if, and provided a satisfactory treaty was reached on the suspension of tests above that threshold, then an extension of the moratorium by a unilateral declaration by the three countries would be made which for a period of time would permit research and development designed to improve the detection system, and thus either lower the threshold or provide means for detecting all underground nuclear tests. That decision having been made, the Atomic Energy Commission, and I personally, felt that our responsibility was to design a research program to accomplish the announced purposes of this Government.

That we have done in cooperation with the Department of Defense, and other agencies of Government.

Mr. CANNON. Members of the Commission have discussed the question among themselves. Have they at any time taken official action, that is, by unanimous agreement?

Mr. MCCONE. I think that the Commissioners are unanimous in the position I have outlined. However, they are all here, and they can all express themselves, sir.

Mr. CANNON. You have discussed this matter, and the matter has been discussed by you with those in charge of our international relations. Briefly, what has been your recommendation at such conferences?

Mr. MCCONE. Our recommendation has been along the lines which I have just outlined. We have pointed out the infeasibility of the monitoring of all underground tests. We have repeatedly pointed out that while seismic improvements might be made, that the means of deceiving the detection system likewise would be perfected, and as a consequence we took a very dim view of the possibility of properly safeguarding against all underground tests. This we have repeatedly pointed out to those who are in charge of the negotiations.

Mr. CANNON. Summing up the whole matter, you consider it inexpedient to enter into such agreement unless we have better assurance and more dependable methods of policing than seem to be provided in the pending negotiations?

Mr. MCCONE. Well, Mr. Chairman, the Atomic Energy Commission must view this from the standpoint of its statutory responsibility and its traditional responsibility and activity which is that of being the Nation's nuclear armorer with responsibility to develop atomic weapons and keep this country in a foremost position in this area.

We recognize that there are a great many other factors that bear on our so-called vital interest and we feel that having advanced our position with respect to our particular statutory responsibility in an articulate persuasive manner, it remains to others with broader authority to make final decisions as to whether this particular situation is paramount to our vital interest, or whether when weighed against other considerations it should be subordinated. That is not our responsibility. It is the responsibility of others.

Therefore, I cannot say that what I could call the action of our Government is inexpedient or improper. Certainly from the standpoint of the AEC's responsibilities, our development program is now being retarded by this test suspension.

Mr. CANNON. But you believe the possibilities of the situation are so serious and there is so much at stake that any agreement on the subject should be very carefully considered before it is entered upon.

Mr. MCCONE. It must be very carefully considered, for two reasons. In the first place, testing underground, even under the so-called threshold, will permit very dramatic and important improvements in weapons of all kinds. Much has been written to the effect that testing underground and under the threshold will permit only the development of the small tactical weapon. This, in the opinion of our scientists and those responsible for our weapon development, is not true. It is their opinion that the warheads for many of our missiles ——— can be dramatically improved in the weight-yield ratio. This would mean that for a given yield the future warhead would be much lighter and therefore the range of the missile much greater. Or con-

versely, for a given weight, the yield would be much greater and therefore more effective.

We have pointed out that these improvements can be made. They could be made by this country and they could be made by Russia if they pursued testing in a clandestine manner, and we did not know that they were carrying on such tests. This worries us, because these improvements are important, second only to the step from the atomic bomb to the hydrogen bomb. I feel that if a country carried on a test program for 4 or 5 years, and we did not, we would end up a second-class nuclear power, and this I do think is a risk that I do not think the United States should undertake. For this reason I feel that we must be absolutely sure that if we do enter in a test suspension agreement, that all parties should abide to it and nobody should have an opportunity to cheat on it.

Mr. CANNON. If we disregard all international questions and completely isolate the problem to one of scientific progress, it is your opinion then that our program of research in this field is not yet complete, and there is much still to be done in research and development from a purely academic point of view?

Mr. MCCONE. I think that is very true, sir: yes.

Mr. CANNON. Under those circumstances, and disregarding the international question, you would prefer to go ahead with your program of research until you have reached a more satisfactory solution of the many scientific problems involved?

Mr. MCCONE. Yes. There are important areas to be considered. The first is the improvement which I have mentioned previously, and secondly there is the question of safety, of carrying on such testing as is necessary to prove beyond doubt that weapons are absolutely safe.

Mr. CANNON. In your opinion, military supremacy in the future will be determined largely by our development and control of nuclear weapons?

Mr. MCCONE. It will, sir, as long as stockpiles of nuclear weapons remain in the hands of world powers. As long as that is true, then I think military supremacy will depend on nuclear supremacy.

Mr. CANNON. Gentlemen, are there any questions?

Mr. MCCONE. Mr. Chairman, since my fellow Commissioners are here, I would like to ask you to suggest that if any of them have any comment to make on the statements I have made that they be permitted to do so, so that the record will reflect the views of the Commission as a whole.

Mr. CANNON. The suggestion of the Chairman is very much in point. Commissioner Graham, will you give us your views on this subject?

Mr. GRAHAM. Thank you, Mr. Chairman. You asked whether this has been a unanimous position of the Atomic Energy Commission. For my part, I can say I have supported the Chairman's views. I would like to make a comment on what he did say about our statutory responsibility, which seems to me is also an important issue. If I may put it in words of a manufacturer, we are making a product which has a very important use to our customer, the Department of Defense. Our manufacturing responsibilities go back prior to that, to the weapons laboratories which have to develop the concepts. Now, it is on this point that heretofore there has been the ability to test the develop-

ment to see whether or not prudence would dictate that the Atomic Energy Commission with its other hat on as a manufacturer would commit that weapon to production. I think this is important, Mr. Chairman, because we come here to you and to the Joint Committee, and we ask for a lot of money.

Mr. CANNON. And you are charged with a statutory duty.

Mr. GRAHAM. Yes, sir; and I don't see how we could come here to you and to the Joint Committee in good faith and ask for lots of money unless we had assurance that it was proper for us to take the weapon design and then go on to manufacture it. But it extends, sir, in my opinion, even more seriously beyond us, and this is to the customer, the Department of Defense, because you in the Congress are also appropriating about $40 billion a year, of which a substantial part is for the military department to spend for the delivery vehicles.

Now, in the future if we are unable to test, I think it would place the Atomic Energy Commission in a very serious position of not being able to say to the Joint Chiefs of Staff nor to the Secretary of Defense we have assurance that this weapon will fire, if necessary, and that it also will be safe to carry. So, Mr. Chairman, if I may say so, putting it in that kind of context, it is the degree of assurance which I think we would lack if we were not able to test underground. This is something which to me, having been in the manufacturing business at one time, is terribly important.

Thank you for letting me make those comments on Mr. McCone's observation about our statutory responsibility.

Mr. CANNON. I thank the gentleman.

Commissioner Floberg, will you give us the benefit of your views on the subject?

Mr. FLOBERG. The farther down the list you go, Mr. Chairman, the less there is to be added to what has been said, because I concur with what both my predecessors have said here. I would like to add a little twist to this presentation from my standpoint, however, and that is this: Sometimes the Atomic Energy Commission is portrayed as being determined to continue the testing of weapons no matter what. This really is not our position and certainly is not mine. I think as the Chairman has illustrated, we are not insisting on testing weapons. What we are insisting on is that nobody else is testing weapons while we are not testing them. This is precisely the point. There is a school of thought which says any agreement on the subject of weapons testing is better than no agreement at all. With this I violently disagree. I think a poor agreement on weapons testing or an unenforceable one is worse than no agreement at all. If you think of the detection system that we have talked about in the past, we have been talking in terms of locating a weapons test within an area of maybe a hundred square miles which is an area 10 miles on a side, up to maybe 400 square miles, which is an area 20 miles on a side. Somewhere in that area you are going to locate an explosion that has taken place.

Now, assuming that the Soviet Union does not interfere with the people who are trying to locate a suspect weapons test in that area, you can figure for youself what the chances are of locating the precise spot. I suppose they are better than one in a million, but I am sure they are not as small as one in a thousand, assuming no

interference, assuming that once you do get hot, you are not obstructed from further investigation. This is precisely the problem that we are facing up to here, and it is precisely the reason why we say that an agreement on this subject must be an enforceable one or it is much worse than no agreement. This is how I analyze this particular subject, Mr. Chairman.

Mr. CANNON. In your opinion, the program of research and development, the area of scientific investigation is still far from complete, there is much to be done from a scientific and academic point of view before you are in a position to solve many of the problems which are before us today.

Mr. FLOBERG. There is no question in my mind, Mr. Chairman, that the progress yet to be made in this field is on a scale comparable to the progress which has already been made. It is not as important whether we make it as it is that nobody else is not making it while we are failing to make it. This is exactly the problem that faces us, I think, here. And that is why we are so concerned that any agreement must be a self-enforcing one. I must say, in underlining what the chairman has previously said, we recognize that the Atomic Energy Commission's interest in this subject is a narrow and parochial one, but a very important one. We recognize that the national interest can supersede our own interests. What we say is nobody else must be testing while we are not testing.

Mr. CANNON. You have not yet been assured that that agreement has been reached.

Mr. FLOBERG. Negotiations are still underway in Geneva as you know, Mr. Chairman.

Mr. CANNON. Commissioner Williams, will you please give us your idea on this?

Dr. WILLIAMS. I would only like to second the expression of responsibility and to emphasize the importance of our duty to make sure that no one else is testing while we are not testing. I think that the key solution to it will lie in the development of detection systems which should be sufficiently sensitive to give us that assurance. The difficulty as I see it is how to get those detection systems experimentally developed in sufficient time so that we have assurance that our enemy has not too long a time in which he could surreptitiously perform tests. I think it is our basic duty to do everything we can to develop those detection systems. Thank you.

Mr. CANNON. And the Commission is now in a position from a purely scientific point of view to proceed with this investigation at the present time?

Dr. WILLIAMS. We have such a program, yes.

Mr. CANNON. Thank you, Commissioner Williams.

Commissioner Wilson?

Dr. WILSON. I agree with the others, Mr. Chairman, and particularly with the way Mr. Floberg puts the situation, that the important thing is to be sure that the other people are not testing or allowed to go on with testing while we are forbidden. I am reminded of the announcement by the Soviets some 3 months ago of a remarkable new weapon. They did not go into any details, but they said they had perfected a remarkable new weapon. Now, how did they perfect it without testing it? I think they must have conducted some sort of

test, presumably underground tests, to be able to say that they have this remarkable new weapon. Yet during that period we were still under the moratorium, which we had agreed to. Also, the Plowshare progam for the peaceful uses of atomic explosives, while it is not supposed to be forbidden by this agreement on weapons testing, it is at present effectively stymied by our moratorium and this keeps us from getting ahead with that important line of work.

Mr. CANNON. And testing is an indispensable phase of research on this problem.

Dr. WILSON. Yes; particularly in the field of peaceful uses because we have done much less in that area than we have in other areas. We have some hopes of developing very clean explosives for peaceful uses of explosives in digging harbors, canals, and things like that. But experiments are indispensable for that development.

Mr. CANNON. The gentleman from South Carolina.

Mr. RILEY. Mr. Chairman and gentlemen, I am glad to learn of your views in regard to this suspension of testing. I personally share with you the concern over the suspension of these tests. I am not a scientist. I am a layman, but I am concerned about the safety of this country and I think that the development of nuclear energy is probably the greatest deterrent to a war that we have in the making today. Unless we keep ahead of our potential enemy in the development of the effectiveness of these weapons, we are going to put ourselves in a vulnerable position. How long is this present moratorium to be in existence? Is there any limit to it, or has that not been decided?

Mr. MCCONE. That has not been decided.

Mr. RILEY. I gather from your remarks that it is extremely difficult, if not impossible, to detect some of the underground tests that someone might be making. Am I right in that, or can you detect them?

Mr. MCCONE. You are correct, in the opinion of our scientists, and I am inclined to accept their opinion.

Mr. RILEY. Anybody who has a light regard for their agreements as some people that we know about in the world would not hesitate to go ahead and test further if they thought they could get by without being detected, in my opinion. You need not answer that.

I believe I discussed with you last year and I would like to have you reiterate it today, that we have more or less just scratched the surface of the development of atomic uses and atomic energy and atomic yield, and the development of these weapons and usages. It is a new thing, and I know much simpler things have taken much longer to reach the full usefulness and capacity of such developments. Do you agree with me that we have just more or less scratched the surface in this field?

Mr. MCCONE. Is this from a military point of view?

Mr. RILEY. Either one—military and civilian usage.

APPLICATION OF NUCLEAR ENERGY

Mr. MCCONE. Yes; I agree. The application of the nuclear weapon to practically all areas of military tactics and strategy has been enormously advanced in the past few years. It has been adapted to our air defense systems, as you know; to our antisubmarine warfare; to tactical warfare by infantry units, and so on. None of this was thought possible a few years ago. But as science has produced weapons that have

been smaller and lighter and therefore more portable, these new uses have come into being. I would expect that there would be some further areas where the military planners would feel that their mission could be better carried out by the use of nuclear devices than by conventional means. In the peaceful uses, I feel that we have only scratched the surface. After all, it has only been 10 years, less than 10 years, that science and industry have been working on this question of the application of nuclear energy to the peaceful activities of life. You are familiar with the developments of nuclear power, the use of radioisotopes in the field of medical science, agriculture, industry. The horizon is just beginning to unfold.

Mr. RILEY. There is no limit on further research into peaceful uses, as I understand it. You can continue that?

Mr. MCCONE. There is no limitation on that whatever.

Mr. RILEY. So our immediate concern is whether or not we are going to be able to keep abreast or ahead of any potential enemy in the development of our defense weapons. I use the term "defense" advisedly because we are not going to attack anybody, at least that is my belief; but we do want a deterrent so that the other fellow will know that we cannot trust him, he cannot trespass on our rights or violate our rights without getting hurt himself.

The only way, in my opinion, we can do that is to keep something better than the other man.

Mr. MCCONE. This is true, Mr. Riley. Our scientists believe that some progress can be made by laboratory means short of testing and by computations and theoretical work, but the progress would be insignificant as compared to the progress that a country would make that was carrying on testing—in a clandestine manner or otherwise.

PEACEFUL USES

With respect to the peaceful uses, one area, and a most important area, that is not proceeding now is the use of nuclear explosions for various developments, such as excavation, the production of oil from shale and oil from tar sands, and of power and other things that the scientists envisage both possible and economical.

I think it is quite interesting that studies indicate the cost of building a canal across the isthmus paralleling the Panama Canal; the estimated saving of doing that work by nuclear excavation rather than by conventional means is in the order of $2 billion.

Mr. RILEY. And in a very short period of time, I should imagine.

Mr. MCCONE. Yes.

Mr. RILEY. Thank you very much, Mr. Chairman.

Mr. MAGNUSON. Mr. Chairman.

Mr. CANNON. The gentleman from Washington.

FOOLPROOF INSPECTION

Mr. MAGNUSON. Mr. McCone, assuming the inclination on the part of Russia to attempt to evade any agreement or violate any agreement clandestinely, is there any real prospect of an arrangement which would stand up, which would be safe? In other words, is there any foolproof inspection system, assuming a lack of good faith on the part of Russia?

Mr. McCone. It is felt that for tests above the 4.75 threshold, which in the opinion of our scientists is the equivalent of about 20 kilotons, which is approximately the size of the Hiroshima bomb, with a reasonable number of on-site inspections such a suspension could be safeguarded.

Mr. Cannon. Off the record.

(Discussion off the record.)

Mr. Cannon. Back on the record.

Mr. McCone. Now, for tests smaller than that, the purpose of the research program which has been announced is to try to develop ways and means of improving the detection system so that either that threshold can be brought down or can be extinguished entirely, and we can say that all tests can be safeguarded.

There are two problems here that run counter one to the other. One is the problem of improving the detection system by improving seismology, better instrumentation, more knowledge of seismology, and after all, that is not a very developed science. The other question is the development of means of deceiving the detection system as now planned or as improved. This is done through a process known as decoupling.

Mr. Magnuson. What was that word?

Mr. McCone. Decoupling, in which the power of the device which is exploded is removed from the surrounding earth environment, and therefore does not create the seismic signal that might be expected. Scientists believe that by placing the device in a large underground cavity, and it would be very large indeed, this decoupling might be in the order of magnitude of, some say, as much as 300 to 1. We have conducted some experiments with small high explosives and have proven that the decoupling theory is proper and that underground explosions can be so placed in the underground that the seismic signal would be very materially less than might be expected otherwise.

Mr. Magnuson. Assuming this threshold of 4.75, are tests within that or under that level useful?

Mr. McCone. Yes.

Mr. Magnuson. In other words, could an enemy make great progress within that threshold?

Mr. McCone. It is our opinion that they could, yes. Before you came in, I discussed that. It is the opinion of our weapons designers, our laboratory directors, that substantial progress can be made. This progress, as I have said previously, is applicable to practically all sizes of weapons. It would involve a very dramatic improvement to certain of our warheads ——— as well as the development of the small tactical weapon.

Mr. Magnuson. So in order to be really safe in any agreement, we have to either lower substantially or eliminate this threshold?

Mr. McCone. That is correct.

Mr. Magnuson. That is all, Mr. Chairman.

Mr. Cannon. Mr. Rabaut.

Mr. Rabaut. Mr. McCone when you used this figure of 300 to 1, do you mean that the ability to make the detection is reduced by that percentage?

Mr. McCone. In the opinion of the scientists what it means is that if an explosion of, say, 300 kilotons was decoupled in a manner which

they envisage as possible, then the seismic signal would be the equivalent of a 1-kiloton explosion, which was not decoupled, but was placed, buried in the ground. That is where this factor comes in. I would like to point out that this is no easy test and the cavity would be very large and very costly. Those who are inclined to discount the theory of decoupling do so not because of challenging the theory, but challenging the practicality and the economics of constructing such underground cavity.

Mr. RABAUT. The cost of construction?

Mr. MCCONE. The cost of construction.

Mr. RABAUT. Now, when you talk about a cavity, that could not be just a hidden cavity in the mountain areas.

Mr. MCCONE. It would be deep underground. You would have to dig down.

Mr. RABAUT. How deep, roughly?

Mr. MCCONE. Well, it depends on the size of the explosion, but it would be quite deep.

Now, there are cavities, as you know, that appear in nature, the salt domes and so forth. Where they are available, then the task is much easier.

Dr. WILSON. Even Mammoth Cave would be a good possibility.

Mr. MCCONE. If such cavities are available to the Soviets in Siberia, and we do not know about that, it might be a very good place to conduct some of these experiments at very little expense.

Mr. RABAUT. With the tested and reliable nuclear adaptations we are now stocking and will continue to stock, do we not now have an adequate retaliatory and deterrent force under any circumstances assuring continued improvement in the delivery system?

Mr. MCCONE. We have a warhead for every weapon system that the military have now in development. We are speaking not of the development of a warhead but improving that which we have developed. This is not important since we have very advanced warheads—it is not important unless the other fellow develops, goes on with his development. If he goes on, and we are stopped, then we arrive at an inferior position. The Atomic Energy Commission, I want to make this abundantly clear, as stated by me earlier and by my fellow Commissioners, is not particularly concerned about our relative position today or in the future provided all abide by the same rules. But what we are concerned about is the fact that we know, and there is no doubt about it, that if we stop and the Soviets continue testing, even under the threshold, and in a clandestine manner, they will within a period of a few years reach a position in nuclear superiority and we think that this is a risk that this country should be alert to.

Mr. RABAUT. I am in accord with your ideas of the development of the bomb and the nuclear tests, that we are about half way. We have as far to go in the future as we have gone so far.

Now, what is it that leads to the feeling that we can rely upon Russia to make an agreement of this kind and of this importance to us when we have had so many difficulties with her in the past? Has that been adequately expressed by your Commission to the agencies of the Government?

Mr. MCCONE. I don't feel that that is within our province, sir.

Mr. RABAUT. You are one of the children of the Congress.

Mr. MCCONE. That is a political matter, however.

(Discussion off the record.)

Mr. CANNON. On the record.

Mr. RILEY. Can we stop human beings from continuing to think and search for solutions to the problems that face us?

Mr. MCCONE. We have a good example of what the human mind does by research and by effort and what France has done. They alone and unassisted have developed the resources for nuclear capability and have built devices and have now exploded two of them, and they intend to pursue this course. They have announced that they are going forward with their program and that they are going to make further tests. They have indicated some of them will be underground, and perhaps all of them will be underground.

When I was there last week, the Minister of the Atomic Energy Commission went down to Corsica announcing through the newspapers that he and the chairman of their Chiefs of Staff, I believe, were looking over a site for conducting underground tests. So I think that is an answer to your question, Mr. Reilly. It is very difficult to get the lid back on this Pandora's box, I think.

Mr. RILEY. Sometimes when you try to put the lid on, you encourage people to make still greater effort.

Mr. MCCONE. I will say from a philosophical standpoint I think we must search in every way possible to stop the proliferation of weapons, stop the development so that more and more countries have them, because I think the danger of a nuclear war with tragic consequences to all of humanity is multiplied manyfold as more nations attain a nuclear capability. The stopping of nuclear tests, the whole program is one of the reasons that it was initiated was the though that if testing was brought to a halt, then development by nations who do not now have nuclear capability would be brought to a halt. There is a certain validity in this point. I think we have to consider that and all other possibilities very seriously.

NUCLEAR EXPERIMENTS IN COMMUNIST CHINA

Mr. CANNON. In that connection, if Mr. Riley will permit, what are the recent newspaper reports to the effect that China is now conducting experiments of this character?

Mr. MCCONE. We do not know that they are, nor do we know anything—that is, I know of nothing of a weapon development program within China. As I said yesterday—and I was in the Dubna Laboratories outside of Moscow—the director of that laboratory had just returned from a visit in China and he left me with the impression that they have a very substantial nuclear research program underway. Whether it is oriented toward weapon development or toward peaceful uses, we have no information.

WEAPONS TEST

Mr. FLOBERG. Could I add one other comment for the committee's consideration?

Mr. CANNON. Yes, Commissioner Floberg.

Mr. FLOBERG. We have illustrated the serious consequences of the cessation of testing on our part accompanied by the testing on the part of the Soviets. A little worse is cessation of testing on our part accompanied with uncertainty as to whether or not the Soviets have discontinued testing. You can readily visualize the potential blackmail 4 or 5 years from now if we have been operating under a system in which we do not happen to have confidence as to the course which the Soviets have been following. I think it would be greatly to their advantage to keep us off balance by this uncertainty as to whether or not they have been testing especially if at the present time they could be exploding these underground every day without our having knowledge of it.

Mr. CANNON. Mr. Boland.

RETALIATORY CAPACITY

Mr. BOLAND. Mr. Chairman, I want to express my regret for having had to leave yesterday and today for a short while. I have not followed the questioning as a result of it, but I assume that you have talked about the retaliatory power which we have. Have you indicated that it is adequate? Is it capable of destroying the enemy?

Mr. MCCONE. I have not made any comment on that. I think it is a military question.

WEAPONS STOCKPILE

Mr. BOLAND. Do you have any opinion on it with respect to our own nuclear stockpile?

Mr. MCCONE. Our nuclear stockpile is vast. I think the question of its effectiveness depends upon the effectiveness of the means of delivery.

Mr. BOLAND. There have been those in high places who have said that our retaliatory system is sufficient to destroy the enemy. You are familiar with those statements. You have read them.

Mr. MCCONE. Yes, sir.

Mr. BOLAND. They have come from fairly good authority. Would you say that these statements are correct?

Mr. MCCONE. I would say that those in responsible positions in the Department of Defense would be the proper authority for such statements.

Mr. BOLAND. You would know from your own knowledge or the Commission would know from its own knowledge what the capability of your particular stockpile is nuclearwise and is that capability sufficient to destroy the enemy?

Mr. MCCONE. The capability of the stockpile—it is sufficient. You see, the adequacy and the effectiveness of the delivery system is a question which I believe should be referred to the Department of Defense.

Mr. BOLAND. You are not responsible for the delivery systems.

Mr. MCCONE. None whatsoever.

Mr. BOLAND. Well, outside of the delivery system do we have a sufficient number of reliable nuclear adaptations that are now in stockpile that are capable of destroying the enemy, assuming that we have an adequate delivery system?

Mr. McCone. Yes, we have an adequate stockpile now and it is building, and it is building in a manner that is phased to new and different delivery systems. The question is under continual study so that we will be assured that at all times, as delivery systems come into being, that the nuclear warheads or bombs will be available in adequate quantity in advance of the scheduled date of readiness of the delivery system.

Mr. Boland. So you phase the adaptation of your nuclear warheads to the particular delivery system that comes into being?

Mr. McCone. That is correct.

COST OF WEAPONS TESTS

Mr. Boland. If we were to continue to test, is there any money in this budget available for testing?

Mr. McCone. There is no money.

Mr. Boland. If we were to test how expensive would it be and how much more would you want?

Mr. McCone. That would depend, sir, on the scope of the program.

Mr. Boland. It would be terribly expensive; would it not?

Mr. McCone. I don't know that it would be terribly. It would be an appreciable amount of money.

Mr. Boland. The Eniwetok proving ground or test site is just a test site.

Mr. McCone. Yes.

Mr. Boland. How much did it cost us last year to keep it in standby? It will cost us $2 million in this budget to put it in mothballs——

Mr. McCone. As I testified yesterday, Mr. Boland, we were spending in the order of $600,000 a month to maintain Eniwetok test grounds. In 1961 we are going to reduce that to an estimated expenditure of $2 million. This will put it practically in mothballs. The Nevada test site is likewise being retained in an inactive status, although there we have the programs of the Rover and Pluto testing which are reactors of different types, and that gives a certain considerable activity to the Nevada test site.

VALUE OF TESTING

Mr. Boland. What I am driving at, Mr. Chairman, is this: Is there any real necessity for further testing of nuclear weapons? Don't we have all of the knowledge that is now essential, provided we have a good delivery system? How much more do we learn by testing nuclear weapons? The big problem here, as I see it, is with respect to the delivery system. Why do we have to continue to test?

Mr. McCone. Going back to previous statements that I have made, and other Commissioners have made, and I think before you came in, we have a weapon, and a good weapon, for every weapon system now definitely planned by the Department of Defense. It might be said that there is no reason to conduct further tests because there is no reason to further develop these weapons. However, we know that each one of those weapons can be very dramatically improved in effectiveness by further testing.

Mr. Boland. Only through testing?

Mr. McCone. Only through testing. Any improvements without testing are very marginal and very questionable. Now that improvement ranges from improvements in the warheads for all of our missiles to the development of more effective small tactical weapons for the ground forces.

This is important only in relation to what other countries are doing. I will repeat what I have said before and that is the Atomic Energy Commission is not advocating testing for merely the purpose of improving our weapons, but it is advocating testing unless we have safeguarded agreement so that we are sure that the Soviets are not improving their weapon system, because if they do and if they pursue testing in a clandestine manner, we are sure, and it is the opinion of the Commission and the opinion of our laboratories who are responsible for weapon development, that they can make such advances that we will become second best in this nuclear weapon field.

RUSSIAN SECRET WEAPON

Mr. Cannon. If the gentleman will permit, Commissioner Wilson alluded to the announcement made by Khrushchev a short time ago to the effect that they had developed a secret weapon of such a potency that it would overreach any previous development in nuclear weapons up to this time. Of course, you have surmised as to what that weapon might be, at least you have surmised in what field it might operate. As near as you are able to say at this time, what in your opinion is the character of this secret weapon which the Russian Premier so strongly emphasized?

Mr. McCone. I have no opinion whatsoever on what he was talking about, Mr. Chairman. Commissioner Wilson was pointing out that if it was a nuclear device which had been dramatically improved, that can only be done by the conducting of tests, in our opinion. On the other hand, it might be some other kind of weapon. It might be a satellite, it might be a missile, it might be a nuclear-powered aircraft, or it might be a means of conducting biological warfare, it might be anything. Mr. Khrushchev just made this flat statement and there is no way of looking into his mind to see what he was talking about.

Mr. Cannon. In your opinion, was he sincere or was he just bluffing?

Mr. McCone. I am not inclined to feel that, from the history of the statements of this nature that have been made by Soviet leaders, that they are inclined to bluff. I think the history has been that when they make a statement as to something that is forthcoming they usually perform. I recall that Molotov, I believe it was, a year or two before they exploded their first atomic bomb, said at the United Nations that the United States should not assume that they would long have the exclusive position. This statement was more or less ridiculed, but it turned out to be right. There have been other statements made. So I am not inclined to think that he is bluffing.

Mr. Cannon. I am inclined to agree with the Chairman and, knowing that nothing the Russians promise in the way of international relationships seems to weigh very heavily on their conscience and that they keep none of their agreements, I must agree that when they have made a statement that they had a weapon it eventually developed that

they did have the weapon. Judged by that criterion, it is probable that they do have something particularly effective.

Mr. McCone. That is correct.

Mr. Cannon. But you have no idea what it is.

Mr. McCone. No; we don't know what it is.

Mr. Cannon. Off the record.

(Discussion off the record.)

Mr. Cannon. The gentleman from Iowa, Mr. Jensen.

WEAPONS DEVELOPMENT

Mr. Jensen. I have always been greatly interested in the discussion that has taken place this forenoon between the members of the commitee and the members of the Atomic Energy Commission. I presume it can be said that the subject which has been discussed here this morning is possibly by far the most important that Congress and the American people have to deal with today. And probably it is to a very great degree in the hands of the Atomic Energy Commission. It is a difficult problem. I find myself rather at a loss to know just how we are going to make much progress in the field of military uses of the atomic bomb unless we experiment with explosions of the bomb. Are we at a complete standstill now so far as experiments with the atomic bomb are concerned, or are you carrying on minor underground explosions? Would you rather have that off the record?

Mr. McCone. No; I will answer that on the record.

Mr. Jensen. All right.

EFFECT OF MORATORIUM ON TESTING

Mr. McCone. We have now been under this moratorium for almost 18 months. For a year or more our laboratories were enormously burdened with digesting the results of the very expensive test program of 1958, and transmitting the results of those tests into weapons. Starting early this year we could see that the time might come when, if these negotiations broke down, testing was to be resumed. This would require proper preparation. We assume that any further testing would be underground because if done properly, the weapon information would develop and it would avoid this question of fallout, which is a highly emotional one, and a great deal of public fear has been, right or wrong, stirred up over the question. So what we did early this year is authorize some excavation to cut down the lead-time. We dug some tunnels and shafts and so forth so that we would be prepared to start a modest program of weapon development in a limited amount of time should a decision be made to proceed. This work has been done. Additionally, we have had our laboratories intensify their theoretical approaches to the question of weapon development, and by so doing we have at least held our own. We have answered some problem through theoretical means that we otherwise would have answered by the very simple means of a test. ———. This has all been done and been done very satisfactorily.

We can pursue weapon improvement from a theoretical standpoint, some improvement will result from this approach. They will not be particularly significant. It is important, however, that we do everything that we can.

VALUE OF UNDERGROUND EXPLOSION FOR FALLOUT STUDIES

Mr. JENSEN. In an underground explosion do you learn little about the degree of fallout?

Mr. MCCONE. There is no fallout.

Mr. JENSEN. There is no fallout in an underground explosion?

Mr. MCCONE. Properly done there is none.

Mr. JENSEN. If properly done. So you learn nothing about fallout in an underground explosion?

Mr. MCCONE. That is correct.

Mr. JENSEN. That is the point I was trying to make. The American people for some time were greatly concerned about this fallout problem. I received many letters from people who were scared to death. They were blaming fallout for a lot of the things that had no connection with it, but they wondered if it was caused by atomic fallout.

PEACEFUL USES OF ATOM

Now, going to the peaceful uses of the atom, I know, of course, of the great progress you have made in that field. I am happy to see Dr. John Lawrence here today. Dr. John Lawrence and his very able staff gave me almost a full day at the laboratory in Berkeley. I was greatly impressed and greatly encouraged by the progress being made there to find the cause and cure of cancer and other diseases. So I requested that Dr. Lawrence come here and be heard before this committee. It was the most encouraging thing that I have experienced in many, many years. I talked with a lady 72 years old while she was on the table ready to take the treatment. She talked in the highest praise of Dr. Lawrence and his great staff and she told me that she was supposed to be dead about 6 or 8 months ago. No doubt she would have been had she not taken this treatment.

Then we watched her take the treatment through a glass encasement and afterward when she got through the treatment, she walked down the steps toward us and she said, "Look at me. I am supposed to be dead several months ago. Look at me now, spry as a kitten." She said, "I have the highest praise. I cannot praise these doctors enough."

So I asked the Doctor how many people he had treated. He said at that time 132, and he had helped a number of them and hurt none. It was a very simple treatment. I hope, Mr. Cannon, since Dr. Lawrence is here, and I know he is a busy man, he will have an opportunity to testify today.

Mr. CANNON. Just as soon as we pass on to the last member of the committee.

Mr. JENSEN. Yes. I know how busy a man Dr. Lawrence is. I don't want us to waste any of his time, because he really has a job to do out there. So I am just happy to know that he is here, and I am sure you are, Mr. McCone.

Mr. MCCONE. Very much so.

Mr. JENSEN. And the rest of the Commission.

EFFECT OF RUSSIAN SPUTNIK I

Going back for a moment to this situation which exists in this old troubled world of ours, I happened to be in London with Mr. Rabaut when Sputnik I was fired. I was quite surprised. The people over there did not seem to be worried about sputnik. We came back home and everybody was worried to death that something was going to fall on their heads tomorrow morning before breakfast. That was about the attitude they took. Shortly after that I made a talk in Seattle, Wash., to the State reclamation association. When I arrived in Seattle, the newspapers were on my doorstep. They said, "How about this sputnik? What do you think about it Congressman?" Many people had asked for a special session of Congress.

Many people were requesting that Congress spend more money. They said how about it, should we have a special session, more money for this program? I said, "We have appropriated over $5 billion for the intercontinental missile and everything pertaining to that, and for our satellite program in this last session of Congress, and I am sure they cannot spend that money properly. So there is no need for a special session as I see it." I said, "There is one thing I want you to remember, if you don't remember another thing I say today, and that is this:" There was a whole roomful of newspapermen. I said, "Remember this. The forces of the Devil never have been nor ever will be the victors over the forces of the Cross as long as God is in his Heaven, and he will be there a long, long time."

They asked me to repeat it. It was published in the paper. I had people write me and say that is the most consoling thing that we have heard. Now, of course, we cannot depend on the good Lord completely because He believes people should help themselves, but if we carry on in a manner that is pleasing to Almighty God in this terrible scary age of ours, we will be all right, and the ungodly enemy, whoever they might be, will fall by the wayside and be destroyed. Whether they be destroyed by fire or by power from above, that is a question. But of course we cannot sit idly by and expect the ungodly people to not do everything in their power to destroy us. That is the devilish attitude that we are up against today.

So in closing I just say I hope the good Lord gives you folks that have this great job to do almost superhuman power to carry on this great task that you have resting on your shoulders today.

That is all, Mr. Chairman.

Mr. CANNON. Off the record.

(Discussion off the record.)

Mr. CANNON. Back on the record.

The gentleman from New York, Mr. Pillion.

WEAPONS TESTS

Mr. PILLION. Mr. Chairman, I would first like to compliment each member of the Commission for their zeal in attempting to safeguard this Nation in the area of the proposed nuclear test suspensions. We started this discussion yesterday afternoon. Part of it was off the record. I hope that everything that is said now will be on the record. There is a large body of opinion in this country that would like to

rush this country into a peace at any price situation and I think that once the facts are known to the public, they can make an intelligent decision. I don't think the public is sufficiently aware of the pitfalls and the dangers of the proposed nuclear test suspension.

Mr. Chairman, yesterday you made a statement that the present moratorium upon your tests has so far in your opinion, and I assume the opinion of the Commission, been a disadvantage to the security of this country. Is that your opinion, Mr. Chairman?

Mr. McCone. I think the statement I made as I recall it was that the test suspension has in my opinion been a greater disadvantage to this country than the Soviet Union. That is my opinion, yes, sir, for the reason that I expressed yesterday.

Mr. Pillion. It may be that this proposed suspension not only has pitfalls but may prove to be almost suicidal. I wonder if we could explore this situation or recap it?

As I understand the situation, under present scientific resources explosions under a figure of 4.75 on the Richter testing scale would not be measurable or would not be susceptible to coming to your attention, is that right?

Mr. McCone. Yes, sir, in the opinion of the sismologists, explosions smaller than that, there would be a high probability that they would escape detection.

Mr. Pillion. That is in the order of magnitude of 20 kilotons.

Mr. McCone. That is correct.

Mr. Pillion. Which is the Hiroshima bomb.

Mr. McCone. Yes. When I say they would escape detection there would be a high probability of their escaping detection with the detection system conceived by the experts at Geneva in the summer of 1958.

Mr. Pillion. An explosion of this magnitude would include practically all of our missile weapons systems, is that correct?

Mr. McCone. No, that is not correct. The magnitude of the explosion of our warheads for missiles, is very much larger, very much larger.

Mr. Pillion. Would there be a great area of tactical weapons in which an opposing power could make tests and perhaps find breakthroughs in the development of tactical weapons that we would not be able to do in the event that this suspension were agreed upon?

Mr. McCone. In the opinion of the scientists there is an area of development of tactical weapons which they consider would be a very significant breakthrough. Also, obviously the present tactical weapon would be substantially improved. I would like here if I could go off the record.

Mr. Pillion. Certainly. Off the record, please.

(Discussion off the record.)

Mr. Pillion. If we were to assume that Red China were to be our opponent in the future, and we were bound by a continued nuclear test moratorium, this moratorium would then work to the advantage of Red China and to the disadvantage of the United States; is that true?

Mr. McCone. Obviously if they continued.

Mr. Pillion. That is right, and we would be stopped. We would be frozen.

NEED FOR ALL POWERS TO AGREE

Mr. McCone. That is right. As I said yesterday, the hope is that if this agreement is reached, then the three powers joining the agreement, Russia, the United States, and Great Britain, would influence other states to come in.

Mr. Pillion. That is not today the present condition or restriction upon the proposed moratorium, is it?

Mr. McCone. No, that is not a condition. The condition of the present moratorium applies to the three negotiating powers.

Mr. Pillion. So if the three powers were to agree to test suspension and Red China was not a party to it, then certainly this agreement would be to the disadvantage of the United States with respect to a possible aggression on the part of Red China.

Mr. McCone. Red China has to be dealt with in some way to make this effective.

Mr. Pillion. That is right. Now, let us assume that Russia and Red China are working in close cooperation, coordination, exchanging scientists, and also exchanging weapons and the testing of weapons. Then again in that even if we were bound by a nuclear test ban, it would work to the disadvantage of the United States. Is that correct, Mr. Chairman?

Mr. McCone. That is correct if Red China were not brought into it.

Mr. Pillion. Now, can anyone here assure this committee that the United States is on a par or ahead of the Soviet in this type of weapon that would be banned, that is, the present system of weapons, missiles, or others, that we are ahead of the Soviets today? Can anyone assure us of that? What I am trying to bring out, Mr. Chairman, is this: If Russia is ahead of us today with a superior weapons system and we stop our testing and they stop their testing, then we are at a disadvantage, is that right. We have frozen two systems in which they have a superior system. Certainly if we are unable to detect further testing on their part, the uncertainty, as Commissioner Floberg has stated, itself would be a tremendous weapon for blackmail of this country. We would be in ignorance of what they are doing. Are you in agreement with that? I think Mr. Floberg made that statement. I would like to reiterate it for the record so that the public can be made aware of the pitfalls and dangers so that we do not rush pellmell into any type of treaty that a certain portion of public opinion might want at the time.

Mr. McCone. I think in connection with your statement it is my conviction that at this point in time we are well ahead of the Soviets in weapon technology, in the devices that we have developed. It is a little difficult, of course, to know exactly where they are. I think it is safe to say that our scientists believe that we are well ahead of them at this point. This is in nuclear technology and the resultant weapon, itself.

I think it is likewise admitted at this point that in the delivery system as represented by the intercontinental ballistic missile, for reasons which your committee well understands and which are quite beyond the province of the Atomic Energy Commission, the evidence is that they are ahead at this point. However, we have made very significant advances in our delivery systems and likewise we have a variety of

means or facilities which are thought by the military to be dependable and most effective, such as our long-range jet aircraft, and so forth.

WEAPONS DEVELOPMENT

The point is that I want to differentiate between the nuclear developments and the weapon system. I think that the evidence will bear out the statement that as of now we are more advanced in weapons development and nuclear weapon technology than the Soviets and certainly any other nation.

I would like to make one other point, Mr. Chairman. That is that I have spoken at various times on the question of the detection of a clandestine nuclear explosion. It might be more appropriate to say that the problem is one of detection and identification because what you will have if you have a detection system installed is that you will have many seismic signals, some very small, but there is no means of knowing whether that seismic signal is an earthquake, a natural event, or an explosion. So the problem is not only getting a signal but determining what that signal means. As you go down into smaller seismic signals you get a vastly increased number of small earthquakes which are not distinguishable from manmade events and this runs into thousands a year. So the problem, for the matter of the record, the problem is detection and identification as contrasted with just receiving a signal on the seismograph.

Mr. PILLION. Mr. Chairman, talking about the delivery and the weapon system, the delivery of the missile depends a great deal on pinpointing your target. It is my opinion that Russia with its vast expanse of Siberia and Asia and Europe can disperse their launching pads, for instance, and other very important offensive areas or weapons over a much larger area than we can, areas that are not mapped the way our areas are mapped. So that when we attempt to send missiles into areas all around Siberia where we do not know the exact location in miles, et cetera, and cannot pinpoint them geographically, we might be at a serious disadvantage, whereas all they have to do is spend a quarter and they can get an accurate map here from any of our departments telling them exactly where many of our most important targets are. The whole efficacy of a missile is dependent upon pinpointing the target. We not only do not know where the target is in Russia; we also do not have the information they have concerning our very important facilities. So from that viewpoint the Soviets certainly have a tremendous advantage.

Mr. MCCONE. This is a question on which we are not in a position to comment because it is a matter of military planning and beyond our province.

Mr. PILLION. Now we have a tremendous stockpile of nuclear weapons and nuclear materials, and I assume Russia has the same. The gentleman from Massachusetts stated that we have the capacity to destroy each other probably a number of times. We will continue to have that capacity, continue to have those weapons even if and when an agreement is arrived at for the banning of nuclear tests. Here we are in a situation where we ban nuclear tests but we still have that great array of armaments on both sides to destroy each other.

PURPOSE OF BANNING NUCLEAR TESTS

What is the purpose of banning nuclear tests? What is the purpose of these negotiations? I don't understand it.

Mr. McCone. I think the purposes are two, sir.

Mr. Pillion. We are still left with these weapons. We still are left with no agreement not to use them.

Mr. McCone. That is correct. Of course, the banning of nuclear tests hopefully would stop the development of nuclear weapons by other powers, and therefore the possible proliferation of them would be brought to a halt. I think that is the most important matter in the minds of the people in our Government that decided on the policy of pursuing this test suspension and I think this is a very valid objective.

Mr. Pillion. May I interrupt there to say that the negotiations have not stopped France.

Mr. McCone. That is correct.

Mr. Pillion. Nor would they, if the three powers have agreed, De Gaulle would not have stopped.

Mr. McCone. He was well advanced, however, before the negotiations had started.

The second point is the feeling that if an agreement can be reached in this area, then it probably opens up the approach to an agreement in further areas of disarmament. I think those are the two basic objectives being sought here.

Mr. Pillion. Yes, but they are both based upon hope and not upon fact. In other words, if you knew for sure that disarmament would follow, then you would agree. That is not a condition to the banning of nuclear tests. The inclusion of Red China eventually is not a condition precedent to the signing of this ban. So that once we sign the ban, the moratorium, the treaty, there is no guarantee that we are going to include Red China. There is no guarantee whatever that it will eventually arrive or transcend this atomic disarmament situation so that the hypothesis on which you are proceeding is merely one of hope and I don't believe in indulging in hope in dealing with the Soviets.

Mr. Cannon. Off the record.

(Discussion off the record.)

Mr. Cannon. On the record.

Mr. Pillion. Thank you, Mr. Chairman. I thank the members of the Commission.

Mr. Jensen. Mr. Chairman, I am happy to see Dr. John H. Lawrence here and hope he can testify soon as he is a busy and very important man in the field of cancer research.

Medical and Biological Applications of Atomic Energy

WITNESS

DR. JOHN H. LAWRENCE, RADIATION LABORATORY, UNIVERSITY OF CALIFORNIA

Mr. Cannon. The Chair will recognize Dr. John H. Lawrence.

Dr. Lawrence, will you come to the table please.

We are honored to have you with us. We will be glad to have you tell us of the work you are doing.

Dr. LAWRENCE. Mr. Chairman and members of the committee, Dr. Dunham has asked me to say a few words about the medical and biological applications of atomic energy. This is a big order and I do not feel that I should take more than 10 or 15 minutes of your time, so obviously I cannot cover the subject. Moreover, if this subject were to be covered fully I think Dr. Dunham, Director of Biology and Medicine of the AEC, would be a more qualified speaker.

On my way here this morning I saw an old friend and former coworker and he reminded me that we had been working in this field for 25 years. It was Paul Aebersold whom I first met in the summer of 1935. At that time he was a young graduate student working in Berkeley with my brother, Ernest O. Lawrence, and I was an instructor in medicine at Yale and went to Berkeley to see what was being accomplished with the first cyclotron. Paul and I were soon infected with the excitement of the early experiments and became interested in the neutron rays seen in Wilson cloud chambers. Very little was known of the possible hazards of the neutron rays produced by the cyclotron, and, remembering the history of X-ray damage to the early workers, this seemed an important place to start work. So, in the summer of 1935, we did our first experiments on the biological effects of neutron rays and set up safety standards for workers around atomic energy installations. Many rats and mice were exposed to neutrons that summer, and fast neutrons were found to be five times as damaging as X-rays. These findings prevented the occurrence of radiation cataracts among the early cyclotron workers whose eager enthusiasm needed the leavening influence of a knowledge of the new hazards involved. Now, of course, radiation protection measures are an integral part of all atomic energy research programs, and have resulted in outstanding safety records. The Atomic Energy Commission through work extending over many years has made it possible for radioisotopes and sources of atomic energy to be used safely thoughout the country in broad programs of research in industry and science.

It was apparent to us in those early days that the high-energy particles accelerated by the cyclotron and the ability to produce artificial radioisotopes provided new tools of nuclear physics and chemistry which could be applied to biology and medicine. This was an exciting prospect, for it promised and did introduce a broad new physical concept into the study of fundamental disease problems. My brother's deep and enduring support of research in human disease and the close collaboration of our physicist associates assisted us greatly as it made the early cyclotron and the new radioisotopes available to us.

First, I should like to speak broadly of radioisotopes and tell a few of the early contributions of the Berkeley Laboratories of the Atomic Energy Commission and then tell of the present uses we are making of the accelerators. Among the many new isotopes discovered in the Lawrence Radiation Laboratory were those which later proved to be the most important ones for medical and biological studies. These were C^{14}, C^{11}, H^{3}, Na^{24}, P^{32}, and many others. Our enthusiastic group was quick to apply the many new isotopes in tracer studies in animals and humans, and other isotopes as they became available.

In 1936 we undertook the first therapeutic use of artificially produced radioisotopes in humans. Based on previous animal studies showing selective deposition of radioactive phosphorus in the bone marrow and in leukemic tissue, we gave radioactive phosphorus to a patient with chronic leukemia. Soon after this, on the same basis, we gave P^{32} to a patient with polycythemia vera. Incidentally, this patient lived out her many remaining years to a normal lifespan. Thousands of such patients have since been treated by this method throughout the world. A few years later I^{131} was introduced here for the treatment of exophthalmic goiter by our late colleague, Dr. Joseph Hamilton.

The use of radioactive colloids in cancer was later ushered in by two of our men. Colloids of chromic radiophosphate and radiogold now comprise the biggest shipment of isotopes from Oak Ridge, indicating their widespread use in the palliative treatment of cancer. Outstanding contributions in the use of radioisotopes for the diagnosis and treatment of human disease have continued to result from the biology and medicine program of the AEC in various installations throughout the United States. Large-scale inexpensive methods of producing radioisotopes in the atomic reactors have made their use in medicine a simple and expedient method of therapy.

Our early interest in the effects of irradiation in the blood-forming system and in the treatment of blood diseases with radioisotopes led directly into later detailed studies of the blood and bone marrow using nuclear tools. These studies have been extremely productive over the years and have resulted in our present ability to determine the sites and mechanism of red blood cell formation and the fate of red cells in irradiation injury and disease using Fe^{59}. A recent development of interest is the discovery of a hormone excreted in the urine which stimulates the production of red cells. This is expected to have future therapeutic value in treating the anemias resulting from irradiation and various diseases.

A fruitful use of radioisotopes in medicine has been in the field of tracer studies where radioisotopes are used as biological "tags" to label and follow substances introduced into the human body as well as substances which are produced within the body itself. By tracing these radioactive tagged substances with various types of sensitive electronic equipment and by radiochemical determinations, a knowledge can be obtained of the functions of the human body and the events which occur in various diseases which had never before been possible. New instruments have recently been devised which enable us to obtain actual pictures of areas in which radioactive substances concentrate, such as a gamma ray camera recently developed in Berkeley for taking pictures of the thyroid gland. Human whole body counters in which radioactivity in extremely small amounts can be counted under low background level conditions are rapidly expanding medical knowledge. These methods of tracing, counting, and visualizing radioisotopes offer one of the most promising means for defeating the multitude of illnesses affecting man. They have already produced a wealth of minute and detailed, though as yet incomplete, information which when assembled into a finished picture will give us the pattern of the functioning of the human body and may lead to improved methods of prevention and treatment.

While all the work with radioisotopes was going on, we were exploring the biological uses of high energy particles from the accelerators. They offered unique possibilities, and I would like to tell how we have subsequently used these accelerators in two fields of research. The first is in cancer therapy and the second is in studying the effect of space radiation on the animal body and other test organisms.

In order to explain these two projects, which we had the pleasure of showing Congressman Jensen when he was in Berkeley, I have brought along several charts. The first chart shows the remarkable characteristics of the high energy beam from the 184-inch synchrocyclotron, which we are using in cancer therapy, and compares it with other forms of irradiation used in this field. On the left are X-rays with which you are all familiar. You can see that the X-rays fan out and disperse as they pass deep into tissue so that if you try to hit an area deep within the body, only a small amount of irradiation strikes the target. Thus, the standard 200–Kev. X-rays deliver a very intense dose to the surface of the skin, but only 20 to 30 percent penetrates to a depth of 8 inches in tissue. On the right side of the chart is an illustration showing the properties of the high energy particle beam from the cyclotron. These particles have the tremendous energy of 900 million electron volts and go straight through tissue with very little scatter or loss of energy. These unique qualities of deep penetration and localization are the reasons we are using the high energy particle beam for cancer therapy. Incidentally, the cyclotron which produces this beam is the instrument that made the first usable amount of U^{235} during the early part of World War II and resulted in the building of the calutron at Oak Ridge for the separation of U^{235}.

The type of cancer we are treating with this beam is widespread cancer of the breast in men and women. In some cases it can be controlled by removal of the ovaries, the adrenal gland, and the pituitary gland. If a person removes one or all three of these glands, he removes the hormones elaborated by these glands which keep the cancer growing after it has spread to the lung, bone, or other organs. When the source of these hormones is removed, in many instances the cancer will start healing up. We have used the cyclotron beam in irradiating the pituitary glands of about 150 patients. By directing the beam to the side of the patient's temple so that it passes through this little cavity within the skull containing the pituitary, we can remove the gland without the necessity of a surgeon opening the skull, pushing back the brain, and removing the gland with suction or with a knife.

Mr. CANNON. You remove the gland without surgery?

Dr. LAWRENCE. Without surgery; yes. The second chart shows the procedure for pituitary irradiation. The patient is seen lying on the table with the beam from the 184-inch cyclotron directed at the side of the patient's head. Her head is firmly held in place within a molded headrest and the location of the pituitary determined. Her head is then gently rotated in the path of the beam so that the stream of high energy particles always hits the pituitary with extreme accuracy. The procedure takes only a few minutes. We give these patients one exposure on Monday, one on Wednesday, and another on Friday and we repeat this the following week for a total of six exposures. About 6 to 8 weeks later we have evidence that the gland has been removed and

can expect that 40 percent of these patients will show a marked improvement in their disease. Many of these patients are still doing well several years later. However, I don't want to give you the wrong impression. This is not a solution to cancer of the breast in women or in men, but it has produced remarkable results in some patients. It is a step in the direction of the control of cancer, and it is a palliative technique for the relief of pain and the extension of life. It is exciting to see the remissions that one gets in some patients, sometimes for many years. We feel that the treatment is worth while, and we will continue it for a considerable period of time. We also are gaining basic information on the hormonal control of breast cancer by intensive studies of this group of patients, using radioactive steroids to follow their metabolism and conversions.

This program is carried out by a team of—originally my brother, Ernest O. Lawrence, and later Dr. Edward McMillan, present Director of the Lawrence Radiation Laboratory, Dr. Cornelius Tobias, and Dr. James Born, who are my close associates, and others.

Mr. CANNON. Before you leave that, off the record.

(Discussion off the record.)

Mr. CANNON. On the record.

Dr. LAWRENCE. The technique we have developed with our team of physicists, engineers, radiologists, and medical people is now being extended to other centers. For instance one of the men working with the cyclotron at Cambridge, Mass., has recently spent some time with us. At Cambridge they are preparing their cyclotron for the treatment of Parkinson's disease. By using this technique with a beam of radiation, one can produce very small lesions in the brain. The beam can be aimed very accurately so that in an animal, for instance, by unloading this energy in a given location you can punch out an area as cleanly and precisely as you could with a surgical knife.

Parkinson's disease, which affects a large number of people, is a brain disorder interfering with the person's ability to control movements. At the present time the neurosurgeons treat some of these cases by surgically entering the brain and destroying certain areas which gives remarkable results to some of these people. In Sweden, the cyclotron is being used for this purpose at the present time.

Now, to go on to another group of patients whom we are exposing to the cyclotron beam—diabetics who are going blind as a result of their disease. Diabetes causes blindness in only a small percent of diabetics, but this, of course, runs into many hundreds in the United States. Many years ago, Professor Houssay discovered that removal of the pituitary gland would ameliorate experimental diabetes in animals. We now have used the cyclotron beam to irradiate the pituitaries in 20 patients who were nearly blind from malignant diabetes, and we are getting very encouraging results. In some patients having progressive partial blindness the process has been slowed down or stopped, and in a few there has been some improvement of vision.

Mr. CANNON. Does it affect other symptoms of the disease or only the blindness?

Dr. LAWRENCE. In most of our patients it cuts down their insulin requirements to a fraction of the original amount, and occasionally to zero requirements. The pituitary, which Harvey Cushing called the

master gland, is a most remarkable gland because it has so many influences on the body.

Mr. RABAUT. What are the effects of the removal of the pituitary gland?

Dr. LAWRENCE. In a man or woman beyond the childbearing age, there is no serious problem, but it does, of course, cause atrophy of all the other glands over which it exerts control, such as the ovaries, the gonads, and the adrenals. But, fortunately, since the discovery of cortisone, one can have his pituitary removed and live normally, provided he takes cortisone and thyroid, although if he were young he could not have children. These people are remarkably well replaced with cortisone and thyroid and for that reason it is possible for the surgeons to remove the pituitary surgically. A man with whom I interned is a leading professor of neurosurgery, and he has removed the pituitary surgically in 350 patients with cancer or malignant diabetes, as have other neurosurgeons.

Now, I should like to go on to the space irradiation studies being done with another accelerator called the Hilac, which is the symbol for heavy ion linear accelerator. Both the Hilac and the 184-inch cyclotron mentioned earlier are used not only for studies in high energy physics by the physicists and the discovery of the new elements by the nuclear chemists but also by us for biological work. We are indeed fortunate to have them in Berkeley and available for our use. The Hilac does not accelerate the light ions like the proton or alpha particles from helium, but it accelerates heavier ones like the nuclei of carbon and neon. These accelerated ions have some of the properties of cosmic irradiation. Interestingly enough, these particles have been studied intensively by several of my colleagues and again the chief architect of their biological effect is Dr. Tobias, who, by the way, is being loaned to NASA for 4 months to help them on their program. Because of the fact that these particles which exist in space can be made on the surface of the earth by the Hilac, studies on the effects of cosmic rays on animals can be done at ground level instead of sending the animals up into space. The elements that have been accelerated thus far in the Hilac have atomic weights up to that of neon, which is 20, whereas the alpha particles which we use in therapy have an atomic weight of only 4.

I have a photograph to show you the importance of learning the effects of space radiation in relation to the problem of getting man into space. Here is a picture of a black rat. The gray hairs seen were produced at the place where carbon nuclei accelerated in the Hilac hit the rat's body. As a result of this experiment, animals were sent into space, and upon their return to earth also were later found to have developed gray hairs where particles in space had struck vulnerable tissue. I simply want to point out by all of this that the Hilac is a very powerful instrument, which has great value in studying the various aspects of radiation in space, such as the Van Allen belts. These studies are of great importance, first from the standpoint of space travel and, second, from the standpoint of shedding great light on the mechanism of how radiation affects tissue, since the heavy particle radiations have special qualities with reference to linear energy transfer. The accelerators located in Berkeley and other atomic energy installations are proving to be uniquely valuable in the ad-

vancement of basic biological and medical research and even in the field of practical therapy of cancer and other diseases.

Now I would like to mention other activities of the Laboratory, without further imposing upon your time by going into a detailed discussion. These programs include—

(1) Instrument development: To devise and develop new instruments for the application of atomic energy to biological and medical problems;

(2) Nuclear investigations in fundamental human physiology and human disease states;

(3) Analytic and metabolic studies in radiation biology at the subcellular level;

(4) Physical biochemistry of macromolecules in radiation injury, cancer, atherosclerosis, and metabolic disorders;

(5) Studies of the biochemical nature of radiation damage to the reticulo-endothelial system;

(6) Metabolism of lipids, lipoproteins, and proteins in various diseases and radiation injury;

(7) Hematological investigation of iron metabolism using radioactive iron;

(8) Pituitary irradition (discussed above);

(9) Research in radiotoxicological health hazards;

(10) Evaluation of fallout problems with respect to humans;

(11) Research on the bilogical effects of fission products;

(12) Internal irradiation and hemotologcial response: The use of radioisotopes in investigation, diagnosis, and therapy of blood diseases, thyroid disease, and cancer;

(13) Studies on heavily ionizing particles and cosmic ray primaries: Space biology (discussed above);

(14) Human whole body counter: Its use in radiation accidents and research;

(15) Medical accelerator design study: Investigation of basic requirements, physical characteristics, and cost of an accelerator for biological and medical radiation studies;

(16) Radiation chemistry: Chemical reactions induced by high energy irradiation in aquo-organic systems of biological importance;

(17) Physiology and chemistry of erythropoietin: A red blood cell stimulating hormone;

(18) Investigation of bone marrow transfusions in the treatment of irradiation injury and other medical problems;

(19) Genetic effects of radiation on mutations in drosophila;

(20) Investigation of the long-term effects of low levels of radiation;

(21) The use of radioisotope-labeled organic compounds in animal biochemistry;

(22) Organic chemistry: The synthesis and study of labeled organic compounds;

(23) Plant biochemistry: Photosynthesis;

(24) Health physics: Shielding from radiation hazards of accelerators;

(25) Biological and physiological effects of high energy particles produced by accelerators.

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Our future planning will continue to be carried on, as in the past, with constant attention to the national needs and the relation of the work to the other AEC laboratories. We wish to continue development and use of new experimental and theoretical tools of nuclear physics and chemistry and to turn them to major unsolved problems in biology and medicine, including the radiation syndrome, cancer, hemopoietic disorders, and atherosclerosis. We will emphasize the utilization of graduate and postdoctoral fellows in research. In this way we can continue to add to the scientific reservoir of the country as we have in the past. We will also continue to aid in our country's international program of cooperation on the peaceful uses of atomic energy by accepting outstanding scientists from foreign countries for research training.

In conclusion, I should like to say that modern high-quality medicine cannot be practiced today without the benefits of radioisotopes and nuclear radiations in the diagnosis and treatment of disease. The Atomic Energy Commission has been responsible for developing and advancing this knowledge throughout the world and in doing so has made an outstanding contribution to medicine in the minds of men of all countries. Thank you.

Mr. CANNON. Thank you very much, Dr. Lawrence. When your transcript comes to you, I wish you would feel free to elaborate. You have taken a very short time this morning. I wish you would take the time to elaborate and express fully what you think should be included.

Dr. LAWRENCE. I will be glad to do so.

Mr. CANNON. The gentleman from Iowa, Mr. Jensen.

Mr. JENSEN. I appreciate very much Dr. Lawrence's appearance here. I wish the doctor would give us a little idea, you can do it on the record if you wish, Doctor, when you get the transcript, of the number of people you have treated and the results, and if you would care to put any letters in, testimonial letters, from people who have taken your treatment, to give the committee an idea of the progress that you have made in this great work which you are doing so well.

Dr. LAWRENCE. I will, sir.

Mr. BOLAND. Mr. Chairman, I just want to compliment the AEC for the appearance of Dr. Lawrence here today. I have been through the installation out there and it is a remarkable installation.

Doctor, I would like to congratulate your staff. It is a tremendously dedicated staff. I was with Dr. Born for 1 whole day and he is a remarkable man, wonderful man. You are fortunate to have him out there. You are one of the great leaders in this field. I want to congratulate the university for the plant that it has and the men who operate it.

Dr. LAWRENCE. Thank you, sir. I am very sorry that I was not there when you were out there.

Mr. CANNON. The committee will stand adjourned.

TUESDAY, APRIL 19, 1960.

REACTOR DEVELOPMENT PROGRAM

Mr. CANNON. We shall now take up the reactor development program. We will insert pages 52 through 117 here.

REACTOR DEVELOPMENT PROGRAM—OPERATING COSTS

Program statement

Estimate fiscal year 1961	$436,200,000
Estimate fiscal year 1960	389,800,000
Increase	46,400,000

The reactor development program includes the development of economically feasible nuclear powerplants for civilian power and commercial ship application, Euratom program, and development of reactors and reactor systems to meet a wide range of military requirements. Briefly stated, the objectives in the separate activities are:

Civilian power reactors

1. To achieve safe, reliable and economically competitive production of electric power from reactors in high energy cost areas of the United States by 1968.
2. To help Euratom nations and other countries effect a transition to nuclear power.
3. To establish a complete and sound technological base for a future atomic energy industry.

Nuclear technology and general support

1. To provide broad support for civilian, maritime, and military reactor programs through the development of materials, moderators, control techniques, separation systems, and waste disposal procedures.
2. To develop, manufacture, and test fuel elements in order to reduce nuclear power costs.

Merchant ship reactors

1. To demonstrate the practicality of nuclear powered merchant ships.
2. To develop nuclear propulsion systems which can compete economically in world commerce.
3. To insure safe operation of nuclear powered merchant ships and their acceptance in world commerce.

Military reactors

1. To develop land-based reactor systems to meet military requirements for powerplants for use at remote locations and for unique military purposes.
2. To develop nuclear propulsion plants suitable for installation in naval vessels ranging from small submarines to large surface ships.
3. To develop nuclear propulsion plants for manned aircraft.
4. To determine the feasibility of nuclear applications in missiles and satellites and to develop those applications deemed feasible.

The increase of $46.4 million in fiscal year 1961 over fiscal year 1960 is broken down as follows:

1. An increase of $5.7 million in the civilian power reactor program primarily for work associated with the cooperative arrangements program.
2. An increase of $5.6 million in the nuclear technology and general support program for the turret and direct conversion work at the Los Alamos Scientific Laboratory and for further expansion of the fuels and materials and reactor component development work.
3. A decrease of $0.4 million in the merchant ship reactor program for research and development on a gas cooled reactor.
4. An increase of $31.3 million in military reactor categories for further expansion in support of Department of Defense and National Aeronautics and Space Administration (NASA) requirements.

5. An increase of $1.5 million in the Euratom program.

6. An increase of approximately $2.7 million for equipment and operational services in support of the enlarged research and development effort.

Summary of estimates by category

Category	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
1. Civilian power reactors:			
(a) Government program	$84,628,520	$97,994,000	$97,900,000
(b) Cooperative arrangements program	15,540,185	19,595,000	25,400,000
Subtotal	100,168,705	117,589,000	123,300,000
2. Euratom program	2,099	500,000	2,000,000
3. Nuclear technology and general support	28,735,758	43,934,000	49,500,000
4. Merchant ship reactors	4,695,851	8,674,000	8,300,000
5. Army power reactors	9,009,951	10,958,000	15,000,000
6. Naval propulsion reactors	83,401,324	78,000,000	85,000,000
7. Airplane propulsion reactors	66,850,575	62,832,000	73,000,000
8. Missile propulsion reactors	22,072,515	34,750,000	43,300,000
9. Auxiliary power sources	7,654,347	12,400,000	14,000,000
10. Operational services	3,252,566	668,000	1,000,000
11. Equipment	21,213,582	19,495,000	21,800,000
Total, reactor development program	347,057,273	389,800,000	436,200,000

Justification of Categories

1. Civilian power reactors, $123,300,000

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(a) Government program:			
(1) Water cooled reactors:			
(a) Shippingport plant reactor	$16,768,025	$19,900,000	$19,000,000
(b) Light water reactors	3,970,723	7,000,000	9,500,000
(c) Heavy water reactors	3,513,715	7,000,000	8,000,000
(d) Plutonium recycle reactors	5,215,348	5,000,000	6,100,000
(2) Organic cooled reactors	2,976,533	5,900,000	7,100,000
(3) Sodium cooled reactors:			
(a) Fast breeder reactors	7,913,234	11,000,000	11,400,000
(b) Sodium cooled converter reactors	6,941,679	9,300,000	6,800,000
(4) Gas cooled reactors	8,781,607	11,500,000	13,000,000
(5) Thermal breeder reactors	19,770,769	8,500,000	5,000,000
(6) Studies and evaluations	1,035,162	2,374,000	3,000,000
(7) Reactor safety	7,711,725	10,430,000	9,000,000
Total	84,628,520	97,994,000	97,900,000

There are four major objectives of the AEC civilian nuclear power program as follows:

(a) Reduce the cost of nuclear power to levels competitive with power from fossil fuels in high-energy-cost areas of this country within the period 1958–68.

(b) Support a continuing long-range program to further reduce the cost of nuclear power in order to increase the economic benefits and extend these benefits to wider areas.

(c) Maintain the U.S. position of leadership in the technology of nuclear power for civilian use.

(d) Develop breeder type reactors to make full use of the nuclear energy latent in both uranium and thorium.

In addition to these major objectives the civilian power program also is concerned with developing nuclear power for industrial applications and exploring varying advanced concepts to determine their application to nuclear power, and

where appropriate, fabricating reactor experiments. There follows the fiscal year 1961 program:

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(1) Water cooled reactors	$29,497,811	$39,990,000	$43,600,000
Shippingport plant reactor	16,768,025	19,990,000	19,000,000
Research and development	13,345,187	13,480,000	8,200,000
Fuel fabrication	1,975,362	3,780,000	9,000,000
Test operations	1,447,476	2,730,000	1,800,000

The Shippingport atomic power station is this country's first full-scale central station nuclear powerplant. This plant was constructed primarily to obtain information relative to the design, operation, and maintenance of central station reactor plants with the objective of advancing the technology of large pressurized water reactors. The development of longer life, higher power density cores is a major goal in this effort. A further objective of the Shippingport project is to demonstrate how a large pressurized water reactor plant can be integrated into an electric utility's power system and to determine the reactor plant's suitability when operated as a base load station, peak load station and as a combination of both.

Research and development.—Analysis and evaluation will continue during fiscal year 1960 on the initial Shippingport core. Development work will continue on the physics and the thermal and mechanical design of Shippingport core 2. A cold critical mockup of core 2 will be performed and its power distribution at operating temperature and cold to hot reactivity swing measured in the high temperature test facility. Development will be continued on natural uranium oxide fuel for use in plate type fuel elements for the core 2 blanket and on enriched oxide fuels and boron burnable poison materials for use in plate type elements in the seed of core 2. Present developments indicate that uranium oxide plate type fuel elements can be operated at higher heat fluxes than uranium oxide rods of practical size and can be operated to higher burnups than uranium zirconium alloy plates. This will permit increases in both core power density and core life. The development and proving out of a high performance fuel element using uranium oxide platelets should permit substantial reduction in fuel costs and should make a significant contribution to the continuing development of the power reactor industry. This fuel element development work on the seed will include (1) extensive irradiation testing of uranium oxide materials with various diluents such as beryllium oxide, zirconium oxide, and a combination of zirconium oxide-calcium oxide, (2) irradiation of lumped burnable poison materials, and (3) the post irradiation examination of these fuels and poisons to determine their life potential. Continued effort will be placed on development of techniques for bonding plates containing oxide fuel materials and improved manufacturing processes for fuel subassemblies and clusters. Research and development cost estimates for fiscal year 1961 are less than estimates for fiscal year 1960 because of the decrease in design and development effort on Shippingport core 2 in fiscal year 1961. However, the physics and metallurgical development programs and evaluation of the plant and core performances will continue.

Fuel fabrication.—The considerable increase in the fiscal year 1960 funding level over that of fiscal year 1959 in fuel fabrication requirements results from the beginning of Shippingport core 2 fabrication. Material for this core will be delivered early in fiscal year 1960. In addition, the fabrication and engineering of Shippingport core 1, seed 3 will commence during fiscal year 1960. Seed 2 for core 1 will be completed and delivered to the site for installation during the first half of fiscal year 1960. The increased funding requirement for fiscal year 1961 results from concentrated effort on the fabrication of seed 3 in addition to the fabrication of Shippingport core 2. Seed 3 is scheduled for completion in fiscal year 1961.

Operations.—The testing and operating program for Shippingport will continue. Seed 2 will replace seed 1 in core 1 during fiscal year 1960. During this refueling, blanket assemblies of core 1 will be removed for testing and analysis

in order to evaluate the effects of irradiation following the operation of seed 1. These one-time refueling costs account for the higher cost estimates during fiscal year 1960. During fiscal year 1961 the performance of seed 2 will be evaluated under various operating conditions. The data obtained will be disseminated for future reference and assistance in the development of improved power reactors.

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(b) Light water reactors	$3,970,723	$7,000,000	$9,500,000
Research and development	3,370,871	5,800,000	6,900,000
Fuel fabrication	10,712	400,000	1,600,000
Operations	575,030	800,000	1,000,000
Reactor experiment fabrication	14,110	0	0

The past achievements in light water reactor technology have indicated that this concept has a high degree of potential for achieving economically competitive nuclear power within the next 10 years. Although the basic technical principles of boiling water reactors have been demonstrated by operation of the BORAX, EBWR, and VBWR facilities, there is still need to carry out additional development work to improve the economics of these plants. Areas of development include (*a*) stability limits and general operating limitations; (*b*) practical application for various types of boiling water cycles, i.e., dual cycle, direct cycle, indirect cycle, forced, and natural recirculation; (*c*) methods for improving cores and system performances; and (*d*) practical means for reducing overall costs.

Research and development

A breakdown of research and development costs is as follows:

	Fiscal year 1960	Fiscal year 1961
Argonne National Laboratory	$2,810,000	$3,400,000
American Standard, variable moderator reactor study	600,000	200,000
Combustion Engineering-General Nuclear Engineering Corp. (superheat)	800,000	360,000
General Electric Co. (superheat)	1,190,000	1,280,000
New work	400,000	1,660,000
Total	5,800,000	6,900,000

The Argonne National Laboratory light water reactor research and development program purposes are twofold: (1) to provide research, developmental, and design support for ANL experimental reactor projects EBWR and BORAX 5 and (2) to advance the technology in those problem areas characteristic of all boiling water reactors.

The areas of work to be continued by Argonne National Laboratory include the following:

1. *Theoretical and experimental stability work.*—Work in this area is an important factor in predicting power performance limitation of boiling water reactor cores.

2. *Heat engineering, including two phase pressure drops.*—This involves the prediction of void distributions and development of methods of analysis and measurement and steam-water separation.

3. *Physics.*—The physics of boiling reactors is more complicated than nonboiling reactors due to the presence of voids and the interdependency of voids, core hydraulics, control rod position, and power level. Mutual compatability of all these factors is required for an efficient and safe core design.

4. *Fuels, cladding, and structural material.*—In these areas the primary goals are to reduce costs, improve performance, and lower corrosion rates.

5. *Water chemistry, fuel element failure detection devices, and decontamination procedures.*—The increase at Argonne Laboratory in fiscal year 1961 over fiscal year 1960 results from the additional effort required to

perform tests on EWBR and BORAX 5 and to analyze their operation. This work will also include performance of critical experiments utilizing plutonium fuels and determination of the effects of plutonium buildup in the EBWR core and the effects of using plutonium spiked fuel elements.

Work was initiated at the end of fiscal year 1959 at American Standard to determine the feasibility of controlling a light-water-cooled and moderated, natural circulation boiling pressure tube reactor by varying the moderator height, which could eliminate the need for conventional control rods and drive mechanisms. The work, which includes theoretical analyses and critical experiments, will be completed within 18 months. The funding in fiscal year 1960 and fiscal year 1961 is the total required to cover the above scope of work.

The Combustion Engineering and General Electric Co. work initiated at the beginning of fiscal year 1960 and which is scheduled for completion in 30 months will develop experimental data and design criteria for application of nuclear superheat in large boiling water reactor systems.

The present boiling water technology results in limiting steam produced to low quality saturated steam. Through generation of superheated steam, improvements could result from increasing the overall cycle thermal efficiency and permitting the use of the standard turbogenerator units now employed in modern conventional powerplants. Accordingly, the light water reactor program has been expanded to include developmental work directed toward the generation of nuclear superheated steam.

The new work to be initiated in fiscal year 1960 contemplates research and development associated with process heat reactors, small water powerplants, additional tasks for the Bonus project and design analysis and simplification of reactor control systems and reactor design improvements. This work is essential for the development of specific reactor projects presently authorized or planned. Research and development tasks such as the following are to be performed in fiscal year 1960–fiscal year 1961 period: bulk boiling studies as they pertain to small size pressurized water reactor, corrosion tests on low alloy steel, corrosion tests on alternate cladding materials, etc.

Fuel fabrication

The schedule of costs for this activity is as follows:

	Fiscal year 1960	Fiscal year 1961
EBWR:		
Core 1 (spikes)	$300,000	$100,000
Core 2 (full core)	0	1,300,000
BORAX 5	100,000	200,000
Total	400,000	1,600,000

EBWR: The fabrication of 5-foot spikes for addition to core 1 and the cost of recovering "cold" scrap from the original portion of core 1 are included in fiscal year 1960 cost estimates. The $1,300,000 in fiscal year 1961 covers a completely new 5-foot core which will be required by the end of fiscal year 1961.

BORAX–5: The estimates cover the fabrication and assembly of fuel elements required for BORAX–5. The reactor is to be completed in early fiscal year 1961.

Operations.—The modification of EWBR and BORAX facilities initiated in fiscal year 1959 will be completed early in fiscal year 1961. Breakdown of the operating costs is as follows:

	Fiscal year 1960	Fiscal year 1961
EBWR	$500,000	$600,000
BORAX	300,000	400,000
Total	800,000	1,000,000

Although neither of these facilities will be in operation during fiscal year 1960, the costs allocated in fiscal year 1960 are required to cover the salaries

of operating personnel and maintenance of the facility. The fiscal year 1961 cost increase results from placing facilities back into operation with full operating crews.

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(c) Heavy water reactors	$3,543,715	$7,000,000	$8,000,000
Research and development	3,543,715	6,640,000	7,000,000
Fuel fabrication	0	300,000	300,000
Operations	0	60,000	700,000

The heavy water reactor development program is directed toward developing a heavy water moderated system capable of economic operation utilizing a natural uranium fuel cycle. Such a fuel cycle eliminates the need for enriched U^{235} fuel.

Research and development.—The major effort will be undertaken by E. I du Pont and will cover the following areas:

(*a*) Physics: A large scale mockup of natural uranium cores using both metal and oxide fuels will be developed to determine nuclear characteristics such as temperature coefficients and reactivity core lifetime.

(*b*) Fuel development: The objective is to develop improved methods of fuel fabrication compatible with low-cost fabrication techniques. This includes primary effort on natural metallic uranium fuel coextruded with zircaloy cladding and a secondary effort on natural uranium oxide fuel elements. Fuel development work will also include testing hydraulics, materials and nuclear performance of developed fuel elements.

(*c*) Materials and components: Work will be directed toward development of suitable materials and components such as pressure tubes, pressure tube connections, seals, pumps and heat exchangers for use under power reactor systems using heavy water as both moderator and coolant.

(*d*) Heavy water leakage control and detection: This work includes developing systems for detecting, collecting and reconstituting heavy water leakage.

(*e*) System design evaluation: An effort will be made to evaluate overall D_2O plant design to determine engineering means of reducing capital costs. Various combinations of systems and components such as pressured versus boiling D_2O coolant and use of pressure tubes versus use of pressure vessel will also be evaluated.

The Du Pont work will be complemented by use of services from Nuclear Development Corp. of America (NDA) and Sargent & Lundy. A cooperative research and development program with Canada is being developed which will be mutually beneficial to the programs of both countries. This program is to include research and development leading to the design and construction of specific reactors planned or to be programed in the Dominion of Canada. The items of work to be done by the USAEC will initially include development, design, fabrication and testing various components such as valves, tubing, onpower fueling machine, heat exchangers, action burst test pressure tubes. Other tasks will be programed as the development, design and construction of specific reactors progress.

Fuel fabrication.—The estimates cover the cost of fabricating the first fuel core for loading in the HWCTR.

Operations.—The fiscal year 1960 estimate covers preparations for the assembly and training of the operating crews. The increase in fiscal year 1961 will result from commencement of full-scale operations of the HWCTR.

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(d) Plutonium recycle reactor	$5,215,348	$5,000,000	$6,100,000
Research and development	5,215,348	3,475,000	3,975,000
Fuel fabrication	0	800,000	725,000
Operations	0	725,000	1,400,000

The plutonium recycle program at the Commission's Hanford Works is design to develop technology applicable to the use of plutonium as fuel in thermal heterogeneous power reactors. Recycling plutonium will permit the use of plutonium produced in power reactors burning natural or slightly enriched uranium, and will permit the development of a reactor system capable of operating on a fuel cycle independent of enriched uranium feed.

Research and development.—The research and development effort during fiscal year 1960 is to be directed toward (1) completion of development tasks related to construction of the plutonium recycle test reactor (PRTR); and (2) advancement of technology for using plutonium as fuel on a safe and optimum economic basis in power reactors. The PRTR will be used to test fuel elements and to demonstrate the feasibility and practicability of the plutonium recycling process. This facility is scheduled for completion during fiscal year 1961. During fiscal year 1960 and continuing in fiscal year 1961, work will be directed toward (1) the design, fabrication, and evaluation of plutonium bearing fuel elements and compatible uranium fuel elements; (2) study of ceramic fuel materials capable of operating at higher temperatures; (3) laboratory testing of irradiated fuel prototypes; and (4) the integration of fuel development with the separation process programs and the fabrication of reprocessed plutonium fuel elements. Activities will continue in the development of higher strength and less corrosive process tubes and fuel jacket tubing, with emphasis on reducing fabrication costs. Methods of reprocessing PRTR fuels will be developed. Development will continue on an experimental-theoretical program which will result in reliable reactor physics formulae that can be used to predict the design and operating characteristics of a reactor operating with recycled plutonium. Inital operation in fiscal year 1961 of the PRTR will provide data to permit evaluation of the fuel materials under operating conditions. The initial beneficial occupancy of the plutonium fabrication pilot plant during September 1959, permitted more extensive investigations for handling and fabricating reprocessed plutonium fuel. Final completion of this facility in fiscal year 1961 will permit development of improved techniques for plutonium fuels fabrication.

Fuel fabrication.—The estimate includes fabrication costs on both plutonium and uranium fuel elements required for the PRTR first fuel loading. Fabrication and irradiations of ceramic-Pu fuels, both spiked and uniformly enriched, will be initiated in fiscal year 1961.

Operations.—During fiscal year 1960, the final hazards report and operating manuals will be completed and an operator training program will be conducted for the PRTR. Reactor operations will begin early in fiscal year 1961. Both test operations and maintenance operations will be carried out on a continuing basis and reactor performance will be analyzed.

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(2) Organic cooled reactors	$2,976,533	$5,900,000	$7,100,000
Research and development	1,844,951	4,570,000	5,300,000
Fuel fabrication	166,377	370,000	500,000
Operations	965,205	960,000	1,300,000

Organic reactors hold promise of low capital cost because the low pressure, noncorrosive and low radioactive characteristics of the coolant permit use of relatively simple and inexpensive components outside of the active core area. The OMRE, located at NRTS, Idaho, was designed as a minimum-cost project with limited scope for investigation of organic fouling and decomposition. Operation of the OMRE has satisfactorily resolved uncertainties in these areas. Therefore, to fully realize the potential of organic cooled reactors, a major increase in effort is warranted to develop better organic coolants, improved fuel elements, more efficient modes of heat transfer, and possible alternate moderators. In addition, research and development work will be undertaken in fiscal year 1960 by a new contractor in support of construction of the experimental organic-cooled reactor (EOCR) project authorized in Public Law 86-50.

Research and development.—The major areas of research and development required on organic reactors relate to coolant technology, fuel element development, and heat transfer. Improvements in organic coolants can lower the makeup costs and improve the heat transfer. Fuel element development can

lower fuel costs by providing lower fabrication costs, longer irradiation times, and improved heat transfer characteristics. Any increase aciheved in the rate of heat transfer will directly reduce the unit capital cost. In addition to the above work, Atomics International will continue general research and development on process systems, advanced engineering, and components. New contractors, Monsanto Chemical Co. and California Research Corp., specializing in organic materials were selected in fiscal year 1959 to augment the coolant technology research and development. Phillips Petroleum Co. is performing the conceptual design and associated R. & D. for the EOCR to be constructed at Idaho. The Fluor Corp. has been selected for final design of the EOCR and new contractors, not yet chosen, will construct and operate the reactor.

The breakdown of the research and development effort by contractors is as follows:

	Fiscal year 1960	Fiscal year 1961
Atomics International	$3,720,000	$4,050,000
Monsanto Chemical Co	125,000	100,000
California Research Corp	125,000	100,000
Phillips Petroleum	100,000	50,000
New contractor (EOCR)	500,000	1,000,000
Total	4,570,000	5,300,000

Fuel fabrication.—In fiscal year 1960 and 1961 four cores for the OMRE will be started or completed. Core No. 3, to be fabricated in fiscal year 1960, will be a uranium oxide matrix stainless steel clad core. Cores numbered 4, 5, and 6 will include a uranium alloy core, an aluminum powder metal (APM) clad uranium oxide core and a duplicate APM clad or a stainless steel clad core. The fourth core (uranium alloy) will be completed in fiscal year 1961.

Operations.—The organic-moderated reactor experiment (OMRE) will be operated throughout fiscal year 1960 and fiscal year 1961. The OMRE was constructed for the purpose of establishing the feasibility of the concept with limited facilities. In order to continue and extend the program to include determination of basic data on radiation damage, organic reactor components, core physics, and heat transfer, the reactor will be modified to provide additional facilities and fuel handling equipment. After reactor modifications, which will require 3 months down time early in fiscal year 1961, a new series of experiments will be initiated to investigate unknown and less conservative operating conditions. These experiments will provide engineering data necessary for the design of improved organic power reactors.

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(3) Sodium cooled reactors	$14,854,913	$20,300,000	$18,200,000
(*a*) Fast breeder reactors	7,913,234	11,000,000	11,400,000
Research and development	6,795,181	8,000,000	8,300,000
Fuel fabrication	618,855	2,300,000	800,000
Operations	499,198	700,000	2,300,000

The primary objective of the Commission's fast-breeder program is to develop the technology of fast reactors to a point where they are practical for economic power production. Effective long-range utilization of nuclear fuels will require reactors that breed more fissionable material than they consume. To date, only fast reactors have demonstrated the ability to breed. An important phase of the fast reactor program is the development of a practical pyrometallurgical process for reprocessing fast reactor fuel. The major facilities in the fast reactor program are: (*a*) The EBR–I which is used for safety examinations and general fast reactor research; (*b*) EBR–II which is presently under construction and scheduled for initial operation in December 1960, and (*c*) the ZPR–III now operable, the ZPR–VI and IX, which will be constructed for critical experiments and other physics tests.

Research and development.—The major effort at the Argonne National Laboratory is on the design, development, construction, and operation of EBR–II, the prototype of a complete fast reactor plant for the production of power. Particular emphasis is being placed on the following: The development of a high-performance fuel element which will operate at high temperatures and permit high burnup; the development of suitable, large liquid metal coolant system components; and the development of an economical reactor complex including fuel handling, reprocessing and refabrication. EBR–II will duplicate the more critical operating conditions anticipated in a large reactor, such as coolant temperature, heat flux, neutron flux, coolant velocity, and power density. Since it is fundamentally an experimental reactor, flexibility of operation and reactor loading are required to permit improvements in performance. Completion of the reactor and power system is scheduled for December 1960. The detailed analyses of systems performance have continued with emphasis on reliability and self-protection under all anticipated reactor conditions. The injection casting process for the first uranium loading of EBR–II has been developed. Further irradiation tests on the fuel elements will continue. Of significance in the research and development effort are the studies undertaken by General Electric on the fast oxide breeder reactor concept (FOB). The objective of this program is to determine the feasibility of operating a fast breeder reactor on a fuel of mixed oxides of uranium and plutonium. This approach, if successful, would lower fuel cycle costs substantially.

The breakdown of the research and development effort is as follows:

	Fiscal year 1960	Fiscal year 1961
Argonne National Laboratory	$7,700,000	$8,150,000
Fast oxide breeder (General Electric)	300,000	150,000
Total	8,000,000	8,300,000

Fuel fabrication.—Fabrication is expected to start in latter part of fiscal year 1960 for core IV (plutonium) for the EBR–I. Fabrication of core I for EBR–II was started in early fiscal year 1960. The increase in the estimate for fiscal year 1960 is associated with the increased effort for fabrication of core I for EBR–II in contemplation of scheduled "dry criticality" in December 1960.

Operations.—The EBR–II is scheduled for "dry criticality" in December 1960, with commencement of power operations in October 1961. The increase in operating costs for fiscal year 1960 is for training personnel and preparing for critical tests of the EBR–II. The increase in fiscal year 1961 results from full-scale operation of the EBR–II. The rigid Mark III core now in the EBR–I was designed specifically to eliminate a prompt positive power coefficient which was thought to be due to the bowing of the fuel rods in the nonrigid Mark II core. The EBR–I will be operated throughout fiscal years 1960 and 1961 with a new core (core IV, plutonium loading).

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(b) Sodium graphite reactors	$6,941,679	$9,300,000	$6,800,000
Research and development	5,367,229	7,900,000	5,300,000
Fuel fabrication	264,063	0	0
Operations	1,310,387	1,400,000	1,500,000

Fundamentally, the Commission's civilian power reactor program includes development of the SGR concept because it offers the demonstrated advantage of producing high grade steam (1,000° F.) from a low pressure reactor system.

The development of the sodium cooled, graphite moderated reactor will not be a major effort in the short-term civilian power reactor program. While the concept shows a potential for achieving power costs comparable to other concepts, all foreseeable improvements are either applicable to sodium coolant for fast breeder reactors or result in modifications to systems looking toward a higher energy neutron spectrum.

Research and development.—The research and development program will be limited to experimental work associated with the operation of the SRE and development of advanced fuels which will contribute to reducing power costs for sodium cooled reactors.

Continued analysis and evaluation of the SRE, development of improved fuel elements and studies on long term reactivity changes will constitute a major portion of the development effort in fiscal year 1960 and fiscal year 1961. Extensive irradiation and hot cell examination of promising fuel materials will be conducted. Investigations of structural and component materials will be continued to permit the attainment of more economical operation at higher performance levels.

The general sodium components development program initiated in fiscal year 1959 to develop improved nonnuclear components for sodium systems will continue through fiscal year 1961 and fiscal year 1962. The improved technology which will result will be applicable to all sodium cooled reactors.

The breakdown of the research and development effort is as follows:

	Fiscal year 1960	Fiscal year 1961
Atomics international	$5,600,000	$4,000,000
Sodium components development	2,300,000	1,300,000
Total	7,900,000	5,300,000

Fuel fabrication.—A second fuel loading of thorium uranium alloy will be installed in the sodium reactor experiment in fiscal year 1960. No fuel fabrication work is contemplated for fiscal year 1960 or 1961.

Operations.—During the remaining portion of fiscal year 1960, rehabilitation of SRE from the faulty condition imposed by the recent fuel element failure shall be the major objective. Following rehabilitation of the SRE, it will be operated on the thorium uranium alloy core to determine the nuclear characteristics of that core and to check out the fuel cycle of that fuel.

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(4) Gas cooled reactors	$8,781,607	$11,500,000	$13,000,000
Research and development	8,781,607	11,500,000	13,000,000

Extensive design and engineering studies undertaken over the past few years have indicated that gas cooled reactors show potential for development as economic power producers. Gas coolant is capable of high temperature operation leading to high thermal efficiency and absorbs very few neutrons making possible systems with high neutron economy. This high neutron economy permits development of systems operable on natural uranium and with conversion ratios of about 1 on the U–Th fuel cycle (hold-own breeders). The objective of the gas cooled program is to investigate and as appropriate develop gas cooled systems with the following advantageous characteristics:

1. A high temperature-high efficiency system with high conversion ratio.
2. A desirable system that is operable on natural uranium.

The flexible experimental prototype gas cooled reactor (EGCR) which will be completed in fiscal year 1963 will be used in the development of these advanced systems through fuel and material tests in its several, large diameter in-pile loops. It will also provide experience in operation of a prototype sized helium cooled power reactor.

Research and development.—Primary development effort on gas cooled systems will be at the Oak Ridge National Laboratory. The Laboratory will emphasize work on developing and testing fuels and reactor materials for the EGCR. In fiscal year 1960, this development program is being expanded to include component work for the EGCR, the assumption of responsibility for fuel and control rod design for the EGCR and initiation of studies on advanced fuels and materials. In fiscal year 1961 fuel development work for the EGCR will be

focused on providing specifications for purchase of the initial fuel loading. Work on advanced systems will be accelerated including experiments on promising advanced fuels and materials. Fabrication of the loops for the EGCR will be initiated. These large loops will be used to test full scale fuel assemblies (fuel rod clusters) of the following advanced technology types: Be, Nb, graphite and ceramic claddings; UO_2, UC, UO_2–BeO and UC–C fuels; and He, CO_2, N_2, etc., coolants at temperatures of 1,500° to 1,800° F.

Kaiser-Allis Chalmers will continue development work in fiscal year 1960 and 1961 in specific support of the EGCR. Hanford will continue research and development work on graphite technology and reactor physics. Construction on the gas loop in the plutonium recycle test reactor will be completed in fiscal year 1960 after which this loop will be used for in-pile graphite CO_2 compatibility studies. The physics studies will be essentially completed by the end of fiscal year 1960. High flux capsule irradiation tests will be made at NRTS by Phillips Petroleum.

During fiscal year 1959, Sanderson & Porter completed preliminary evaluation of a pebble bed powerplant. During fiscal year 1960 evaluation and development of this system will continue to establish its potential as a high temperature-high conversion ratio gas cooled system.

The breakdown of the research and development effort is as follows:

	Fiscal year 1960	Fiscal year 1961
Oak Ridge National Laboratory (R. & D.)	$8,250,000	$7,350,000
Kaiser—AC (R. & D.)	1,000,000	1,000,000
Fabrication of EGCR loops	0	4,000,000
Phillips Petroleum	350,000	300,000
General Electric (Hanford)	1,350,000	350,000
Sanderson & Porter	550,000	0
Total	11,500,000	13,000,000

The increase in fiscal year 1961 is for the initiation of fabrication of the large loops for the EGCR. The decrease in the Hanford cost results from completion of fabrication of a graphite-CO_2 compatability testing loop in the plutonium recycle reactor.

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(5) Thermal breeder program	$19,770,769	$8,500,000	$5,000,000
Research and development	17,920,929	6,500,000	3,500,000
Operation of HRE–2	1,849,840	2,000,000	1,500,000

During fiscal year 1959 three fluid fuel reactor concepts were under active development. At the close of fiscal year 1959, it was determined that a transition would be made from the fluid fuel program to a thermal breeder reactor program (TBRP). Under the AEC's present program, the scope of this activity has been enlarged to include the evaluation of all types of thorium reactor systems.

Fertile thorium can be used in either converter or breeder reactors as a means of extending energy resources. The use of thorium in converters is currently being investigated in a number of reactor concepts which have economic promise; however, considerable development work remains to be done in connection with the U^{233} fuel cycle. Development of thorium breeder reactors has been centered primarily on the fluid fuel systems, particularly the aqueous homogeneous reactor.

In its initial phases, the thermal breeder program will be characterized by basic research and development work and evaluation studies to determine the most promising type(s) of systems for continued development. Evaluation studies on thermal breeders have been undertaken by a special group at ORNL, and are scheduled for completion by the end of fiscal year 1960. Limited R. & D. will be continued on the aqueous homogeneous reactor concept. Work on the

molten salt reactor and the liquid metal fuel reactor concepts will be terminated at the end of fiscal year 1960 unless evaluation studies now under way indicate that the breeding potential of either of these concepts is sufficiently strong to warrant continuation of limited R. & D. work until final selection is made.

A comprehensive, imparitial engineering and cost analysis will be made of nuclear power reactors utilizing thorium. This study will take into account experimental information from the second homogeneous reactor experiment (HRE–2) and will include comparisons of fluid fuel as well as solid fuel thorium breeders. It should also include an evaluation of nonbreeding, high conversion ratio concepts. These evaluations will indicate the economic potential of the various concepts as well as their effect on extending nuclear fuel resources.

(6) Studies and Evaluations:

Fiscal year 1959	$1,035,162
Fiscal year 1960	2,374,000
Fiscal year 1961	3,000,000

The direction of any research and development program requires not only critical technical evaluation of the existing program and project but also careful planning for future programs. These activities require continuing advice from authorities in various fields in preparation of detailed technical studies and reports and performance of specific computational studies. This assistance is obtained from the national laboratories insofar as possible. Some information, such as information on specific concepts and costs, must be obtained from authoritative industrial contractors. In addition, this program enables the introduction of new ideas which may eventually be more promising than those currently under development. The work in studies and evaluation is therefore generally categorized as being in three areas:

National Laboratory Technical Assistance Groups.—A nucleus of a technical assistant group is required at each of the national laboratories. These groups perform specific computational analysis, special research investigations and consultant services. Arrangements have been made which enable them to call upon experts with specific knowledge in particular fields. These groups assist in studies to make cooperative analyses, task force studies, conceptual design studies relating to planned programs and evaluation of new reactor concepts.

Evaluation studies.—This activity is comprised of studies by industrial contractors on the various technical and economic aspects of concepts which have reached the engineering stage of development. It also includes work now being undertaken to determine existing and future conventional and nuclear power costs in the United States and abroad and the factors affecting these costs.

New reactor concepts.—New ideas and concepts for civilian nuclear reactors are introduced into the program by performing evaluation feasibility studies aimed at clearly defining the problems and the potential of these new ideas and concepts. During fiscal year 1960 studies on the sodium modular reactor, mercury-cooled fast reactor, and fluidized bed reactor were performed. Studies on the mercury-cooled and fluidized bed reactors will continue during fiscal year 1961. In addition work on other new reactor concepts such as the suspended fuel and boiling slurry reactors may be performed.

The breakdown of cost estimates in studies and evaluations is as follows:

	Fiscal year 1960	Fiscal year 1961
Technical assistance groups	$580,000	$900,000
Evaluation studies	668,000	300,000
New reactor concepts program (including fabrication of reactor experiments)	1,126,000	1,800,000
Total	2,374,000	3,000,000

The level of effort in fiscal year 1961 is being budgeted at slightly below that which will be expended in fiscal year 1960. This decrease will come about as a result of a lower level of effort on new reactor concepts. The total funding for technical assistance and evaluation will be approximately the same as in fiscal

year 1960 but a greater amount of reliance will be placed on the national laboratories' technical assistance groups.

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(7) Reactor safety	$7,711,725	$10,430,000	$9,000,000
(a) Thermal reactor safety	5,826,958	9,330,000	7,900,000
1. Reactor transient tests	4,032,732	7,365,000	5,700,000
2. Chemical reaction	772,949	1,024,000	1,200,000
3. Reactor containment	1,021,277	941,000	1,000,000
(b) Fast reactor safety	1,884,767	1,100,000	1,100,000

(a) *Thermal reactor safety*

The objective of this program is to develop an understanding of hazards associated with reactor operations. These hazards can result from reactor power runaway, containment rupture, and fission product release to the environment. The goal then is to provide information which will lead to safe and economical reactor design and operation. The work is divided into three categories: reactor transient tests, chemical reactions, and reactor containment.

1. *Reactor transient tests.*—Reactor transient tests are undertaken to study the abnormal behavior of reactors, in the range between normal power operation and runaway leading to destruction. In this way, we learn the factors which lead to self-shutdown and means for preventing runaway and destruction. These studies have principally been devoted to heterogeneous water reactors, simple homogeneous systems and lately expanded to include organic moderated reactors. The projects included here are the various SPERT reactors, KEWB, and the theoretical support work.

SPERT I is unpressurized and work will continue in the transient test of various core types. SPERT II, designed for operation at 300 p.s.i.g. and 400° F. will be completed in 1960 and will be used to test the effects of various moderators upon kinetic behavior. SPERT III started operation in December 1958. It is fully pressurized and will be used to study the safety of boiling water and pressurized water reactors. SPERT IV, which will be completed in fiscal year 1961 is a swimming pool test facility to study hydrodynamic and oscillatory effects upon kinetic behavior. A new cylindrical core has been under study in the KEWB program which concerns the safety of homogeneous reactors. KEWB work should be completed in fiscal year 1961. Theoretical programs accompany the reactor transient test programs to provide an understanding of the phenomena and to develop simplified theory.

Increased costs in fiscal year 1960 are due to the nonrecurring cost of heavy water for SPERT II and the cost of fabricating SPERT IV. Increased operating costs in fiscal year 1961 over fiscal year 1959 are due to the full-time operation of three SPERT reactors and the start of SPERT IV operation.

2. *Chemical reactions.*—The principal purpose of work under this heading is to study metal reactions with water, metal ignition, fission product release, and other reactions known to be hazardous to reactor operation. The energy released by a metal-water reaction during a reactor accident could be great enough to rupture the core vessel and the outer containment shell. Metal-water reaction work will be continued and extended to include in-pile tests using the TREAT reactor.

Considerable progress has been made in the study of the ignition properties and behavior of zirconium and uranium. This work will continue and will be expanded to include plutonium and thorium ignition. Experimentation will be expanded in the vital area of fission product release from molten or burning reactor fuel. Determination of the kinds of fission products released will be studied under many conditions of simulated reactor accidents. In-pile tests of fission product release will be conducted to provide a realistic correlation with laboratory tests. Fiscal year 1961 costs are increased over the previous year due to the start of new work at Brookhaven and the start of in-pile tests at ORNL.

3. *Reactor containment.*—The objective of this work is to study the dynamic properties of pressure vessels and outer containment systems to improve safety and reduce costs of construction. The structural properties of containment

systems are studied under conditions simulating reactor destruction. Activities under this program will continue and include dynamic and static rupture of pressure vessels, blast and shock effects, mechanics of missile penetration and fragmentation, leak testing, and the use of industrial construction for low overpressure containment systems. Increased costs in fiscal year 1961 are due to new work in the field of energy absorption schemes, low overpressure confinement systems with filters and scrubbers, and the preparation of a containment technology handbook.

(*b*) *Fast reactor safety*

This activity involves the operation of the transient reactor test facility (TREAT) which was completed in fiscal year 1959 and was designed to provide reactor power excursions to melt proposed fuel elements, primarily for fast reactors, without damage to the facility. Experimental efforts initiated in fiscal year 1959 will be continued through fiscal year 1961. This involves melt-down programs of complicated arrays of fuel pins in both flowing and nonflowing sodium.

Power demonstration reactor program assistance

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
A. Fiscal year 1958 authorization:			
(1) Yankee Atomic Electric Co	$1,275,630	$371,000	0
(2) Fast reactor systems	241,988	600,000	$775,000
(3) Consumers Public Power District, Hallam	5,920,583	4,268,000	1,500,000
(4) Rural Cooperative Power Association	71,240	100,000	125,000
(5) City of Piqua, Ohio	2,858,280	389,000	0
(6) Chugach Electric Association of Alaska	2,104,965	0	0
(7) Northern States Power Co	1,516,840	2,500,000	500,000
(8) Carolinas-Virginia Nuclear Power Group	1,206,917	2,600,000	2,000,000
(9) East central and Florida west coast nuclear power groups	343,742	1,967,000	2,000,000
B. Fiscal year 1960 authorization:			
(10) Philadelphia Electric Co	0	5,100,000	4,500,000
(11) Intermediate size reactor (organic)	0	100,000	2,000,000
(12) Consumers Power Co. of Michigan	0	1,500,000	3,500,000
(13) Other prototype reactors	0	100,000	1,000,000
C. Fiscal year 1961 authorization	0	0	7,500,000
Total	15,540,185	19,595,000	25,400,000

A stated purpose of the Atomic Energy Act of 1954 provides for a program to encourage widespread participation in the development and utilization of atomic energy for peaceful purposes. The power demonstration reactor program initiated for this purpose, has as its objective the stimulation of industrial participation in the development and application of nuclear technology to the generation of power and other civilian uses. This program is directed toward meeting this objective.

On January 10, 1955, the Commission announced this program and issued its first invitation to industry to submit proposals for the design, development, construction, and operation of demonstration nuclear powerplants. Since that date additional invitations have been issued.

The fiscal year 1960 cost estimate is the pricing out of anticipated cost for contracts that have been negotiated or to be negotiated in fiscal year 1960. The net increase of $5.8 million in fiscal year 1961 is as follows:

(1) A $4.2 million increase to provide research and development assistance on projects authorized in fiscal year 1960 Authorization Act, as follows: (*a*) $900,000 for the large water reactor prototype, (*b*) $1,900,000 for the intermediate size (organic) reactor prototype, and (*c*) $2 million for unsolicited proposals (consumers of Michigan) from the utility industry to construct nuclear powerplants.

(2) A $7,500,000 increase for research and development assistance on power demonstration reactor projects proposed for authorization in the fiscal year 1961 Authorization Act.

(3) A decrease of $5.9 million in cost for those projects now under existing contracts. In fiscal year 1960, research and development assistance for Yankee Atomic Electric Co. and the city of Piqua, Ohio, will be completed.

(1) Yankee Atomic Electric Co.:

Fiscal year 1959	$1,275,630
Fiscal year 1960	371,000
Fiscal year 1961	----------

It is anticipated that all the tasks will be completed in fiscal year 1960. The major efforts in fiscal year 1960 will be the inpile loop testing and the postirradiation examination of fuel elements. The final specifications for the fuel rod and fuel assembly will be produced. The reactor physics and chemistry studies and an analysis and evaluation of the safety aspects of the finalized reactor design completed will be compiled by the end of fiscal year 1960.

(2) Fast reactor systems:

Fiscal year 1959	$241,988
Fiscal year 1960	600,000
Fiscal year 1961	775,000

It is planned to continue throughout fiscal year 1961 research and development assistance to industrial sponsored fast breeder power reactors. This support work will be incremental to the fast breeder technology activity in the Government base program and will be carried out in AEC laboratory facilities. Consulting service, critical experiments, and irradiation services and fuel studies will be the principal services performed.

(3) Consumer Public Power District:

Fiscal year 1959	$5,920,583
Fiscal year 1960	4,268,000
Fiscal year 1961	1,500,000

During fiscal year 1960 and fiscal year 1961 overall development of design criteria for system and components and coordination of engineering design will continue.

In the developmental area, proof testing of many systems and components was started in fiscal year 1959 and will extend into fiscal year 1960, and in a few cases continue into fiscal year 1961. Testing of components exposed to high thermal stresses, of minor hardware for service in sodium systems, of improved sodium instrumentation, and of a sodium-heated steam generator model will be completed in fiscal year 1960. Reliability and service life tests presently underway for the control elements, shim and safety rod mechanisms, moderator-reflector assemblies, sodium pumps, the plant control system, and the fuel-handling cask and equipment will extend into fiscal year 1961.

Detailed studies of the hydraulic characteristics of fuel elements designed for the first and second cores at Hallam will be performed in fiscal year 1960 and 1961.

In the important area of fuel development work which was started in fiscal year 1958 to develop UO_2 fuel will be completed in fiscal year 1960 with completion of postirradiation inspection of specimens. Programs aimed toward development of uranium 10 molybdenum fuel will be completed in fiscal year 1960. The developmental effort for uranium carbide fuel will extend well into fiscal year 1961 and will involve irradiation testing of the fuel, development of fabrication techniques, and performance of experimental studies.

(4) Rural Cooperative Power Association:

Fiscal year 1959	$71,240
Fiscal year 1960	100,000
Fiscal year 1961	125,000

The fiscal year 1960 estimate includes the continuation of costs incurred for this project. The fiscal year 1960 estimate includes costs related to the training of supervisory personnel of RCPA in preparation of the operation of the reactor.

A slight increase in anticipated expenditure during fiscal year 1961 is due to additional training costs prior to reactor startup.

(5) City of Piqua, Ohio:

Fiscal year 1959	$2,858,280
Fiscal year 1960	389,000
Fiscal year 1961	----------

In fiscal year 1960, the preconstruction research and development work will include fuel element development, critical experiments, and operation of process prototype equipment. Piqua prototype fuel elements will be irradiated and examined in a hot cell. The hot cell examinations will indicate the stability of the fuel element. In addition, process and product specifications will be written. All necessary physics parameters will be determined by a critical experiment. The operation of a prototype purification system, a residue burning system, a filtration system, and a degasifier system will provide evaluation of the system performance and establishment of optimum operation conditions. The research and development program will be completed in fiscal year 1960.

(6) Chugach Electric Association of Alaska:

Fiscal year 1959	$2,104,965
Fiscal year 1960	----------
Fiscal year 1961	----------

The Commission has decided that the sodium deuterium reactor will not be constructed at Anchorage, Alaska, as previously planned under the power demonstration program. No costs are contemplated to be incurred under this project in fiscal year 1960 and fiscal year 1961.

(7) Northern States Power Co.:

Fiscal year 1959	$1,516,840
Fiscal year 1960	2,500,000
Fiscal year 1961	500,000

In fiscal year 1960, the critical facility will be completed, including the superheat portion and will be operated throughout the year. Work will continue on problems associated with the boiling portion of the Pathfinder Reactor and research and development on the nuclear superheater will reach a peak during the year. Fuel development will also be at its peak, including the operation of the heat transfer test facility and irradiation testing at General Electric test reactor. Design specifications are expected to be completed for long leadtime components resulting in a decrease in the rate of research and development expenditure toward the end of fiscal year 1960. Fuel element development work will account for about one-half of the estimated cost in fiscal year 1961 and final nuclear analysis of the Pathfinder core will account for the balance. Core No. 1 for the Pathfinder Reactor will be ordered early in fiscal year 1961 with delivery to take place at the end of fiscal year 1961.

(8) Carolinas-Virginia Nuclear Power Association, Inc.:

Fiscal year 1959	$1,206,917
Fiscal year 1960	2,600,000
Fiscal year 1961	2,000,000

In fiscal year 1960, it is anticipated that most of the experimental programs will be well underway. Much information will be forthcoming as a result of the various theoretical and experimental investigations. As a result of the various studies and evaluations of available results, those areas requiring additional investigation will be defined and scheduled for further studies. The results available from those problems which have been resolved will be used in specifying the conceptual design of the prototype plant. Construction of the plant should commence during this period utilizing information generated in the R. & D. program. In fiscal year 1961 the preconstruction research and development will come to an end. All the information sought through the various experimental and study programs should be available for incorporation into the prototype plant design. The end of fiscal year 1962 should see the completion of the prototype plant.

(9) East Central and Florida West Coast Nuclear Power Groups:

Fiscal year 1959	$343,742
Fiscal yetr 1960	1,967,000
Fiscal year 1961	2,000,000

Research and development during fiscal years 1960 and 1961 will be centered on fuel irradiation, corrosion tests, pressure tube development, and development and testing of transition seals and tube flow lines. A loop for irradiation of complete fuel assemblies will be fabricated in fiscal year 1960 and operated during late fiscal year 1960 and in fiscal year 1961. Critical experiments are planned during this period. This research and development work is directed

toward establishing the technical feasibility of the system at the earliest possible date.

(10) Philadelphia Electric Co.:

Fiscal year 1959	0
Fiscal year 1960	$5,100,000
Fiscal year 1961	4,500,000

The contracts with Philadelphia Electric (to build and operate the plant) and General Atomic Division (General Atomic is performing research and development work on the nuclear portion of the plant) were signed on August 27, 1959. Emphasis in the fiscal year 1960 and fiscal year 1961 program at General Atomic will be on fuel element development including basic materials work, design, fabrication techniques, and irradiation testing. Present plans call for construction of a gas-cooled inpile loop at the General Electric test reactor for full-scale fuel element irradiation. Additional work in the program will include physics studies, heat transfer studies and experiments, development of fission product trapping devices, and development of piping and components for high temperature helium service.

(11) Intermediate size organic prototype reactor:

Fiscal year 1959	0
Fiscal year 1960	$100,000
Fiscal year 1961	$2,000,000

To provide research and development assistance in connection with the construction of an intermediate size, of not less than 50 electrical megawatts, organic prototype reactor. It is anticipated that the total estimated cost of such assistance will approximate $7 million. In the event satisfactory proposal for construction of this reactor on a cooperative basis is not received by the Commission, the Commission will proceed with the design, construction, and operaiton of the prototype at its own expense.

(12) Consumers of Michigan:

Fiscal year 1959	0
Fiscal year 1960	$1,500,000
Fiscal year 1961	3,500,000

Research and development effort for fiscal year 1960 and fiscal year 1961 will involve exploring the feasibility and studying the performance of prototype UO_2 fuel elements at high power densities (approximately 90 kilowatts per liter) and average burnups at 10,000 MWD/per metric ton, utilizing fuel elements manufactured from existing fabricating processes.

(13) Other prototype reactor:

Fiscal year 1959	
Fiscal year 1960	$100,000
Fiscal year 1961	1,000,000

To provide research and development assistance in connection with the proposed construction of other prototype reactors which may be of a boiling, pressurized water-type or other type reactors. It is anticipated that the total estimated cost of such assistance will approximate $4 million.

C. Cooperative projects (fiscal year 1961 authorization):

Fiscal year 1959	
Fiscal year 1960	
Fiscal year 1961	$7,500,000

Additional authorization is being requested in fiscal year 1961 to provide research and developmental assistance. The requested authorization includes a total of $15 million obligational authority in fiscal year 1961 for unsolicited proposals associated with the planned fiscal year 1961 cooperative arrangement construction program. The fiscal year 1961 estimate of $7,500,000 shown here is the anticipated cost to be incurred under contracts to be negotiated. The balance of $7,500,000 is included in the "Goods and services on order" portion of the budget.

Reactor manufacturers have recently announced their readiness to construct large-size reactors under terms which may warrant one or more utility companies to initiate construction. In addition, the utility industry is studying various reactor concepts and may propose construction of prototypes of such

concepts. In such event it would be desirable for the Commission to have authority to provide research and development assistance as necessary to achieve an advancement in the reactor art. While it is believed that $15 million may be necessary should two or more unsolicited proposals be received, alternatively all or part of such authority could be used to support a third-round invitation for the construction of a prototype of one of the reactor concepts now being studied should construction of a prototype be desirable.

Summary of authorization and obligations for cooperative arrangements, fiscal yea 1958–61 Cooperative Power Reactor Demonstration Program (CPRDP)

	Total authorizat on		Obligations (in thousands)				
	Previous estimate	Revised estimate	Fiscal year 1958	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961	After fiscal year 1961
A. FISCAL YEAR 1958—CPRDP							
1st round:							
Consumers Public Power District, Hallam:							
Preconstruction R. & D	$18, 165	$18, 165	$2, 464	$6, 438	$4, 268	$1, 500	$3, 495
Unusual maintenance and fuel cycle costs	8, 000	8, 000	8, 000	0	0	0	0
Construction	24, 013	24, 013	6, 500	6, 347	9, 402	1, 744	20
Total consumers	50, 178	50, 178	16, 964	12, 785	13, 670	3, 244	3, 515
Fast breeder R. & D.[1]	3, 600	3, 600	695	21	600	2, 284	0
Total, 1st round	53, 778	53, 778	17, 659	12, 806	14, 270	5, 528	3, 515
2d round:							
Elk River:							
Preconstruction R. & D	0	0	0	0	0	0	0
Construction	9. 397	9, 397	9, 269	127	1	0	0
Postconstruction	2, 176	2, 176	2, 176	0	0	0	0
Total, Elk River	11, 573	11, 573	11, 445	127	1	0	0
Piqua:							
Preconstruction	3, 500	3, 500	200	2, 858	442	0	0
Construction	7, 332	7, 332	0	7, 211	121	0	0
Postconstruction	3, 318	3, 318	0	2, 288	1, 030	0	0
Total, Piqua	14, 150	14, 150	200	12, 357	1, 593	0	0
Chugach:							
Preconstruction	8, 155	8, 155	2, 300	−113	0	0	5, 968
Construction	9, 229	9, 229	0	0	0	0	9, 229
Post-construction [2]	2, 500	2, 500	0	0	0	0	2, 500
Total, Chugach	19, 884	19, 884	2, 300	−113	0	0	17, 697
Total, 2d round	45, 607	45, 607	13, 945	12, 371	1, 594	0	17, 697
Third round:							
Northern States:							
Preconstruction R. & D	7, 500	7, 500	5, 500	2, 000	0	0	0
Postconstruction R. & D	1, 000	1, 000	500	310	190	0	0
Total, Northern States	8, 500	8, 500	6, 000	2, 310	190	0	0
Carolinas-Virginia:							
Preconstruction R. & D	10, 145	10, 145	0	10, 145	0	0	0
Postconstruction R. & D	3, 760	3, 760	0	1, 472	2, 288	0	0
Total, Carolinas-Virginia	13, 905	13, 905	0	11, 617	2, 288	0	0

See footnotes at end of table.

Summary of authorization and obligations for cooperative arrangements, fiscal year 1958–61 Cooperative Power Reactor Demonstration Program (CPRDP)—Con.

	Total authorization		Obligations (in thousands)				
	Previous estimate	Revised estimate	Fiscal year 1958	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961	After fiscal year 1961
A. FISCAL YEAR 1955—CPRDP—continued							
Third round—Continued							
East Central Nuclear Group—Florida West Coast:							
Preconstruction R. & D	$8,646	$8,646	0	$6,097	$2,549	0	0
Postconstruction R. & D	3,000	3,000	0	2,344	656	0	0
Total, ECNG-FWCNG	11,646	11,646	0	8,441	3,205	0	0
Total, 3d round	34,051	34,051	$6,000	22,368	5,683	0	0
Additional proposals	0	0	0	0	0		0
Balance not applied	1,677	1,677	0	0	982	0	$695
Subtotal:							
Operating	85,142	85,142	21,835	33,860	13,005	$3,784	$12,658
Construction	49,971	49,971	15,769	13,685	9,524	1,744	9,249
Total, fiscal year 1958 program	135,113	135,113	37,604	47,545	22,529	5,528	21,907
B. FISCAL YEAR 1960—CPRDP							
Other prototype reactor, R. & D	3,000	4,000	0	0	4,000	0	0
Intermediate size organic reactors, R. & D	8,000	7,000	0	0	7,000	0	0
Unsolicited proposals—Consumers of Michigan, R. & D	5,000	5,000	0	0	5,000	0	0
Philadelphia Electric:							
Preconstruction R. & D	12,500	12,500	0	0	12,500	0	0
Postconstruction R. & D	2,000	2,000	0	0	2,000	0	0
Total, Philadelphia Electric	14,500	14,500	0	0	14,500	0	0
Small pressurized water prototype reactor construction	10,000	12,000	0	0	12,000	0	0
Improved cycle boiling water reactor construction	15,000	13,000	0	0	13,000	0	0
Subtotal, operating	30,500	30,500	0	0	30,500	0	0
Subtotal, construction	25,000	25,000	0	0	25,000	0	0
Total, fiscal year 1960 program	55,500	55,500	0	0	55,500	0	0
C. FISCAL YEAR 1961—CPRDP							
Unsolicited proposals (or alternative)	0	15,000	0	0	0	15,000	0
Construction of organic reactor (or other alternatives)	0	25,000	0	0	0	25,000	0
Total, fiscal year 1961	0	40,000	0	0	0	40,000	0

[1] Total estimated AEC R. & D. cost: $4,450,000. Obligations prior to fiscal year 1958: $141,000.
[2] Total estimated AEC R. & D. cost: $12,380,000. Obligations prior to fiscal year 1958: $1,725,000.

Power reactor demonstration program, fiscal year 1958 authorization

Specifications	1st invitation		
	Yankee Atomic Electric Co.	Consumers Public Power District	Power Reactor Development Co.
Location	Rowe, Mass.	Hallam, Nebr.	Monroe, Mich.
Type of reactor	Pressurized water	Sodium graphite	Fast breeder.
Heat output	482,000 kilowatts	245,000 kilowatts	300,000 kilowatts.
Electrical output, net	110,000 kilowatts	75,000 kilowatts	90,000 kilowatts.
Amount of fuel	22,800 kilograms	35,200 kilograms	1,930 kilograms.
Enrichment, percent U^{235}	3.4	3.0	25.6.
Reactor outlet temperature (degrees Fahrenheit).	Approximately 600	945	800.
Reactor pressure	2,000 pounds per square inch.	Negligible	Negligible.
Steam conditions (pounds per square inch at degrees Fahrenheit).	540 at 475	800 at 825	600 at 740.
Criticality	July 1960	November 1961	September 1960.

Specifications	2d invitation		
	Rural Cooperative Power Association	Chugach Electric Association	City of Piqua
Location	Elk River, Minn.	Anchorage, Alaska	Piqua, Ohio.
Type of reactor	Boiling water	Sodium cooled	Organic moderated.
Heat output	73,000 kilowatts [1]	40,000 kilowatts	45,500 kilowatts.
Electrical output, net	20,000 kilowatts	10,000 kilowatts	10,500 kilowatts.
Amount of fuel	4,219 kilograms thorium.	10,000 kilograms	6,250 kilograms.
Enrichment, percent U^{235}	Fully	About 2	1.8.
Reactor outlet temperature (degrees Fahrenheit).	531	950	575.
Reactor pressure	875 pounds per square inch.	Atmosphere	120 pounds per square inch.
Steam conditions (pounds per square inch at degrees Fahrenheit).	600 at 825	850 at 850	450 at 550.
Criticality	January 1961		September 1961.

Specifications	3d invitation			
	Northern States Power Co.	East Central and Florida West Coast Nuclear Power Groups	Carolina-Virginia Nuclear Power Association	Philadelphia Electric
Location	Sioux Falls, S. Dak.	Not announced	Parr Shoals, S.C.	York County, Pa.
Type of reactor	Boiling water	Gas-cooled D_2O moderated.	Pressure D_2O	Gas-cooled graphite moderated.
Heat output	203,000 kilowatts [2]	150,000 kilowatts	60,500 kilowatts	115,000 kilowatts.
Electrical output, net	62,000 kilowatts	50,000 kilowatts	17,000 kilowatts	40,000 kilowatts.
Amount of fuel	6,605 kilograms	17,300 kilograms	3,410 kilograms	190 kilograms U^{235}, 1,190 kilograms thorium.
Enrichment, percent U^{235}.	1.8	1.84	1.8	93.
Reactor outlet temperature (degrees Fahrenheit).	825	1,050	574	1,382.
Reactor pressure	600 pounds per square inch.	500 pounds per square inch.	1,500 pounds per square inch.	300 pounds per square inch.
Steam conditions (pounds per square inch at degrees Fahrenheit).	520 at 825	1,000 to 1,800 at 1,000.	415 at 725	1,450 at 1,000.
Criticality	May 1962	December 1963	June 1962	December 1963.

[1] Includes 14,800 kilowatts of conventional superheating capacity.
[2] Includes 39,000 kilowatts from superheater.

2. Euratom program, $2 million

The research and development portion of the joint United States-Euratom cooperative program is aimed primarily at the improvement in performance of the power reactors to be constructed under the joint program and at lowering fuel cycle costs. The incorporation of such an activity in the joint program has been based on experience within the U.S. atomic energy program which has demonstrated repeatedly that major gains can be achieved in improving the performance and in lowering the operating costs of large reactors if an associated research and development program is established. It is believed that such a program will lead to substantial improvements in power levels, and savings in the fuel cycle with a resultant lowering in unit power costs. A vigorous research and development program also is expected to provide further important assurance to the industries involved that costs will decrease with time and experience so as gradually to diminish the necessity for the U.S. Atomic Energy Commission to provide fuel element guarantees as contemplated by section 4 of the Euratom Cooperation Act of 1958.

Under the terms of the agreement for cooperation between the United States and Euratom, the joint R. & D. program is established for a 10-year period. The agreement stipulates an expenditure for each side during the first 5 years of about $50 million. Subsequently, only one reactor proposal—as compared with a minimum of four originally contemplated—was received for the 1963 phase of the program. This is for the SENN boiling water reactor. Because the maximum number of reactors now anticipated under the program is three, of which two would not come into operation until 1965, it is now anticipated that a maximum of about $20 to $25 million will be spent by the United States on the joint R. & D. program during the first 5 years.

To date the Joint Research and Development Board has approved U.S. proposals totaling $1.7 million. It is estimated that $0.5 million will be costed for this work in fiscal year 1960 with the balance of $1.2 million accruing in fiscal year 1961. In addition, it is anticipated that approximately $0.8 will be costed for contracts yet to be authorized by the Joint Research and Development Board.

3. Nuclear technology and general support, $49,500,000

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
(a) Engineering physics and advanced reactor development	$8,710,881	$14,294,000	$16,850,000
(b) Reactor fuels and materials development	9,429,199	16,600,000	18,100,000
(c) Reactor components development	1,722,953	2,355,000	3,300,000
(d) Separations and development	5,542,828	6,159,000	6,170,000
(e) Radioactive residue processing and controls	3,329,897	4,526,000	5,080,000
Total, nuclear technology and general support	28,735,758	43,934,000	49,500,000

The nuclear technology program includes three areas of research and development which apply to long-range reactor problems and problems that are common to several reactor concepts and thus not suitable for support under the specific projects. These areas are: (1) a program in reactor physics and in the development of advanced reactor types, either those whose feasibility is in doubt or those not devoted to power production; (2) a program of fuels and materials development directed toward improving the performance of reactor fuels and toward obtaining a better fundamental understanding of reactor materials; and (3) a reactor components program directed toward the solution of fundamental engineering problems applicable to all reactor concepts, such as heat transfer, and to the development of components generally useful in power reactors. In addition to these three programs applied directly to reactor design, there are two other programs of concern to the general reactor development effort. The program in chemical separations is directed toward reduction of this item in the fuel-cycle cost for power reactors and toward development of processes that may be used by industry in taking

over this field. A program in effluent dispersal and control is directed toward understanding the fate of radioactivity released to the environment and toward devising effective and economic methods of waste control. The general objectives of nuclear technology programs are to provide basic data on reactor systems and related problems, to carry out engineering development of a general and fundamental nature, to investigate the feasibility and potential of new methods for improving reactors, and to provide tools such as test and research reactors and remote handling devices for use in reactor and general nuclear research and development.

(*a*) Engineering physics and advanced reactor development:

Fiscal year 1959	$8,710,881
Fiscal year 1960	14,294,000
Fiscal year 1961	16,850,000

Included under this activity is provision for continued and in some cases, expanded effort on a number of separate but related major subprograms. Although the objectives of each subprogram may differ somewhat in detail, they can be considered as necessary either to the provision of additional fundamental reactor physics information required for advances in reactor technology, or to the development of improved tools for nuclear research. The subprojects provided for under this heading are discussed below.

(1) Reactor physics:

Fiscal year 1960	$5,887,000
Fiscal year 1961	6,270,000

Provided for here are studies on typical combinations of reactor materials to determine their neutron efficiency and reactivity life. Also included are investigations aimed at the accurate measurement of constants fundamental to reactor design, such as fission cross-sections and the number of neutrons produced per fission. The determination, compilation and dissemination of reactor physics information permits the designers of specific reactors to produce cores with higher power outputs, longer reactivity lifetime and greater safety.

The increase in fiscal year 1961 is due to additional effort on the reactor physics of high power cores of advanced design.

(2) Radiation effects:

Fiscal year 1960	$805,000
Fiscal year 1961	1,005,000

Included under this heading are the investigations and determination of the effects of reactor radiations on reactor materials other than fuel. The physical reaction of material exposed to the various types and levels of radiation found in a reactor environment is an important factor in reactor design. As more knowledge is gained in this area it will be possible to design reactor systems having increased life and lower cost through the use of less costly materials. The increase in fiscal year 1961 will provide for needed development of techniques for irradiation testing and postirradiation measurement of effects.

(3) High flux research reactors:

Fiscal year 1960	$1,377,000
Fiscal year 1961	855,000

This program provides for the developmental effort required to furnish research scientists with improved research tools in the form of high flux research reactors. In addition, a more general and smaller activity is conducted, aimed at the establishment of characteristics and feasibility of specialized research reactors. The reduction in fiscal year 1961 is due to the initial phasing out of the developmental program on the ORNL isotope production reactor, as well as a reduction in level of effort devoted to the general development of specialized research reactors.

(4) Reactor evaluations:

Fiscal year 1960	$150,000
Fiscal year 1961	200,000

This program represents the effort required to (*a*) develop techniques for evaluating exising and proposed reactor types and (*b*) investigate advanced

reactor concepts in order to determine their potential and the areas in need of additional development. Both of these areas will contribute much to the validity and certainty of program guidance.

(5) Advanced test reactors:

Fiscal year 1960	$325,000
Fiscal year 1961	300,000

Provided for here is the effort required to perform studies on the conceptual design of an advanced test reactor of relatively high flux. This effort is in line with the requested authorization for an advanced test reactor.

(6) Direct conversion:

Fiscal year 1960	$1,550,000
Fiscal year 1961	2,400,000

The direct conversion of fission heat to electrical energy promises significant reductions in the size, complexity, and, therefore, the cost of nuclear-fueled powerplants. To investigate this approach, two programs have been undertaken: one on measurements to determine the effect of inpile irradiation exposure on a wide variety of thermoelectric materials with the purpose of development of a thermoelectric fuel element; and the other, at LASL, on the development of the plasma thermocouple, a thermionic device. Both of these programs have shown promise and, in view of the accomplishments to date, it is planned to devote additional effort in this area in fiscal year 1961.

(7) Advanced reactor development:

Fiscal year 1960	4,200,000
Fiscal year 1961	5,820,000

The Los Alamos Scientific Laboratory, through its long association with weapons and other military development programs, has acquired a wealth of information and experience on plutonium and high-temperature materials. As a result of their background in these areas, they have been engaged in the development of two advanced type reactors, Lampre and Turret. The Lampre concept is a fast reactor employing molten plutonium as fuel and has an excellent potential for rapid breeding and high burnup. The Turret program is aimed at the development of an extremely high temperature (2,500°) gas-cooled reactor which has promise as a source of high-temperature process heat as well as contributing valuable information on fission product radioactivity in such systems. The increase in fiscal year 1961 is related to the assembly of a 3-megawatt (heat) reactor experiment for the Turret program.

(b) Reactor fuels and materials development:

Fiscal year 1959	$9,429,199
Fiscal year 1960	16,600,000
Fiscal year 1961	18,100,000

Objectives of investigations performed under this category of research are—

1. Assistance toward realization of economic nuclear power by more efficient utilization of fissionable and fertile materials in reactor cores;

2. Obtaining fundamental, design, and handbook information on nuclear fuels and materials;

3. Selection and evaluation of potential reactor materials as to feasibility, application, and production.

Research necessary to meet the first objective requires intensive efforts to increase reactor core life, burnup, stability to radiation, to reduce fuel-fabrication costs, and to insure high-temperature operation of fuel assemblies. To implement the second objective requires careful fundamental and engineering research to determine basic physical constants and operational data over a broad range of temperature, environment, stress, and radiation fields. The third objective necessitates studies on materials now considered exotic or scarce, such as rare earth metals, complicated refractory alloys, ceramics, cermets. Methods of production, fabrication, testing, and utilization must be established on materials which possess potential reactor worth.

Specific activities performed under this heading provide for:

(*a*) Acquisition of information on the physical, mechanical, and nuclear properties of metals, alloys, and materials which have or may have value in reactor application; and

(*b*) Continuation of projects initiated under the fuel cycle development program, which are aimed at the development, design, fabrication, testing, and irradiation of prototype fuel elements.

Significant effort will be underway on use of plutonium, thorium, and U^{233} as reactor fuel alloys, achievement of high-power, longer life fuel elements; understanding and development of radiation stability of materials under high neutron flux for extended periods; simplification of fabrication techniques for fuel cores; advanced nondestructive testing research, both fundamental and applied. Increase in costs in fiscal year 1961 over fiscal year 1960 of $1,500,000 is due to utilization of available metallurgical facilities for plutonium investigation at Argonne; increased effort at Oak Ridge on development of the thorium U^{233} fuel cycle; initiation of the third phase of the fuel cycle development program which requires the fabrication and irradiation testing of prototype fuel assemblies in reactors; and development of production of UC in quantities for use as a base fissionable material in reactor cores.

(*c*) Reactor components development:

Fiscal year 1959	$1,722,953
Fiscal year 1960	2,355,000
Fiscal year 1961	3,300,000

The purposes of activity provided for under this program are to develop both fundamental information and equipment which will permit the building of reactors having higher power density, more effective means of operation and control, greater reliability, and, ultimately, lower costs. This program falls into five related but separately identifiable areas as follows:

(1) Heat transfer coolants and fluid mechanics:

Fiscal year 1960	$816,000
Fiscal year 1961	1,350,000

Funds requested for this program will provide for studies pertaining to all types of coolants: Liquids, liquid metals, and gases. Much of this program is of a basic nature directed toward development of needed information for use by reactor designers, or toward means for increasing the heat transfer and heat transport properties of conventional coolants as required by the trend toward high power and higher flux density cores. The increase in fiscal year 1961 is largely attributable to the initiation of work at several locations on studies in the following representative areas: Liquids in the critical region, new mixtures of coolant gases, interaction effects in simultaneous heat and mass transfer theory, heat transfer to intermediate and high quality steam, and dynamic response of heat exchanger systems.

(2) Instrumentation and control:

Fiscal year 1960	$394,000
Fiscal year 1961	820,000

Development effort provided for under this item is concerned with the development of new techniques and better instrumentation and control systems for all types of reactors. Work is proceeding with the development of more effective and reliable instrumentation, automatic controls for power reactors, techniques, and equipment for studying reactor kinetics, and modernization of reactor instrumentation and control systems to utilize the latest developments in electronic circuitry and components. The large amount of attention now being given to the fuel cycle and its demand for higher power, high temperature, and higher burnup cores has created a need for better incore instrumentation. The increase in fiscal year 1961 represents the initiation of new work at several locations required to develop and study such items as radiation resistant electronic components, new methods in measuring particle density in fluids, neutron flux temperature, and coolant pressure and flow insider reactor cores.

(3) Pressure vessel and materials fabrication:

Fiscal year 1960	$140,000
Fiscal year 1961	155,000

Work provided for under this subactivity is concerned primarily with studies of such things as the stresses at nozzles and openings of pressure valves, investigations of stress cycling fatigue and pressure vessel materials, and the development of welding and fabrication techniques. All of this work is directed at the

development of criteria which will enable more accurate design for pressure vessels in nuclear service which, it is anticipated, will lead to more economical manufacture of these expensive reactor components. The increase in fiscal year 1961 represents the initiation of an important aspect of this program involving a study of techniques and the development of equipment for remote inspection and testing of pressure vessels and piping which have seen service in radiation environments. It is becoming increasingly important that we have some means of determining the condition of pressure components which have been in service for long periods of time since the effect of radiations may well affect the safety of operations.

(4) High temperature components:

Fiscal year 1960	$65,000
Fiscal year 1961	225,000

Work performed to date in the field of high temperature components indicates that there are problems to be solved concerning the equipment and materials required to handle high temperature gas coolants. In particular, this involves such items as compressors, valves, and other mechanical equipment for use with helium. The increase in fiscal year 1961 reflects the first full year of the program to investigate and develop components for use with high temperature helium.

(5) Remote handling equipment:

Fiscal year 1960	$949,000
Fiscal year 1961	750,000

Provided for here is the development of remote handling equipment, particularly mechanical manipulators and viewing systems. In order to facilitate investigations of highly radioactive materials, constant improvement in methods for the remote handling and examination of such materials must be developed. The immediate problems of most concern relate to the needs of plutonium fuels program. Work conducted in this area deals with the development of viewing systems such as shielding windows, shielded optical equipment, and development of manipulators and robots for working in hot laboratories. It is anticipated that fiscal year 1961 costs will decrease due to the nonrecurring nature of certain costs incurred in fiscal year 1960.

(*d*) Chemical separations and development:

Fiscal year 1959	$5,542,828
Fiscal year 1960	6,159,000
Fiscal year 1961	6,170,000

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Aqueous chemical processing	$2,795,728	$3,062,000	$2,650,000
Volatility processing	1,039,765	1,440,000	1,550,000
Closed cycle-low decontamination processing	1,707,335	1,657,000	1,970,000
Total chemical separations development	5,542,828	6,159,000	6,170,000

Chemical separations and development programs are directed toward these objectives:

1. The development of processing techniques for new and advanced fuels in proportion to their anticipated importance.
2. The demonstration of process methods for economical fuel cycles using important fuel types.
3. The facilitation of industrial participation in the processing of reactor fuels.

The latter objective is particularly appropriate to the high decontamination, aqueous, and volatility methods.

Closed fuel cycle technology is becoming increasingly important because, to the extent to which advanced fuels development results in higher and higher burnups, processing and refabrication of the unburned and bred materials will require

semiremote and completely remote handling techniques. This exerts tremendous influence on the whole course of fuel cycle development.

(1) Aqueous chemical processing:

Fiscal year 1959	$2,795,728
Fiscal year 1960	3,062,000
Fiscal year 1961	2,650,000

Major goals are the development of increasingly versatile dissolution "headends" for major fuel types, scouting and early development on potentially important new fuels, and investigation of radical new processing approaches which may assist early industrial participation. In the development of low enriched aqueous processing methods for civilian fuel types, special consideration is being given to (1) universally applicable mechanical handling devices for sectioning and decladding, (2) the Zircex process in treating Zr fuels, and (3) other promising alternates for stainless, Zr, molybdenum, and niobium fuel systems. Particular emphasis will be placed on ceramic systems, especially of the uranium-carbide and graphite types. Under military programs, several fuels now under consideration present extremely difficult processing problems, and increased effort will be expended in these areas.

The reduction in fiscal year 1961 arises from unusual expenditures in fiscal year 1960 for expendable equipment required by the new hot pilot plants at ICPP and special mockup work in conjunction with the single-reactor, small processing unit demonstration.

(2) Volatility processing:

Fiscal year 1959	$1,039,765
Fiscal year 1960	1,440,000
Fiscal year 1961	1,550,000

General development at ORNL of volatility technology (in which NaF absorption beds are used for UF_6 recovery) will be continued. Assuming successful demonstration of naval fuel processing using the existing fused salt dissolution system, work will continue on demonstration of applicability to other major fuel classes. Laboratory development and design work will be conducted to supplement this program.

General development at ANL of volatility technology (in which uranium is purified by fractional distillation) will be continued. Process demonstration studies will be conducted in the existing pilot plant. Major emphasis will be placed on the development of technology for the recovery of plutonium by volatility processes, the development of corrosion resistant construction materials, and broadening the applicability of volatility systems to other fuel types.

Based on promising results obtained thus far, additional effort will be directed toward financing bed dissolution of reactor fuels utilizing various fluidized media. An alternate process using liquid NO_2–HF will also be investigated. Both of these relatively new ideas seem to offer unusual promise in developing a more universal volatility headend system.

(3) Closed cycle-low decontamination processing:

Fiscal year 1959	$1,707,335
Fiscal year 1960	1,657,000
Fiscal year 1961	1,970,000

This program is in actuality broader in scope than implied by the terms chemical processing or pyrometallurgical processing alone, since it involves reprocessing through decontamination, reenrichment, and refabrication, performed in a facility closely integrated with a reactor. This approach contrasts with most fuel cycle development work which is based on the major assumption that manual handling will be required at some point during the fuel cycle and that high fission product decontamination is therefore essential.

Work will be continued on second generation process techniques for the EBR–II type reactor system. In particular, special emphasis will be placed on the new pyrocadmium and pyrozinc systems which appear to be a major contribution to low decontamination processing technology due to their greater flexibility and ease of operation compared with slagging methods.

Recognizing the implications of isotopic contamination and the increasing importance of ceramic fuel types, work will be continued on the feasibility and

early equipment studies on uranium-carbide, and thorium-uranium-233-low enriched fuels.

(e) Radioactive residue processing and controls:

Fiscal year 1959	$3, 329, 897
Fiscal year 1960	4, 526, 000
Fiscal year 1961	5, 080, 000

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Residue treatment	$1, 025, 204	$1, 316, 000	$1, 550, 000
Residue disposal	2, 304, 693	3, 210, 000	3, 530, 000
Total radioactive residue processing and controls	3, 329, 897	4, 526, 000	5, 080, 000

Radioactive residue processing and control encompasses the entire area of waste disposal from the development of concentrate and contain techniques for the high level wastes produced in waste processing plants to the dilute and disperse approach applicable to the low level waste solutions found in chemical laboratories, reactor cooling water, etc. Emphasis ranges from the primarily chemical and engineering aspects of treatment to the investigations of environmental capacities and various methods of radioactive effluents control.

(1) Residue treatment:

Fiscal year 1959	$1, 025, 204
Fiscal year 1960	1, 316, 000
Fiscal year 1961	1, 550, 000

Work under this activity is primarily directed toward the chemical and chemical engineering problems associated with the treatment of the extremely radioactive wastes produced in chemical processing plant operations. These waste problems begin with the dissolution of the fuel element itself and are intimately affected by dissolution agents and flow-sheets as well as by actual storage technology.

In particular, work is being directed toward the reduction to solids approach with emphasis on the techniques developed for installation in the ICPP waste calcination facility. Work will continue on development of (1) second generation calcination techniques, (2) feasibility of equilibrium, high temperature storage, and (3) extension of the calcination approach to stainless and zirconium fuel types. The feasibility of removing partially or full decontaminated diluent alloying materials will be explored on a unit operations basis. The feasibility of high decontamination separation of specific long-lived fission products will be pursued as it applies to improved waste storage, rather than to recovery for industrial utilization.

(2) Residue disposal:

Fiscal year 1959	$2, 304, 693
Fiscal year 1960	3, 210, 000
Fiscal year 1961	3, 530, 000

The handling and disposal of radioactive wastes is a general facet of all phases of peaceful nuclear energy operations. The disposal of radioactive wastes is potentially a major nonbeneficial effect on the public and its resources. Radioactive waste materials in either gaseous, liquid, or solid forms are evolved in essentially all operations associated with nuclear energy facilities. Because of the nature and characteristics of the radioactivity involved, its ability to cause damage to human tissue, and its potential danger as an environmental contaminant, the safe handling and final disposal of wastes from the nuclear energy industry are integral and important aspects of these operations. Basically there are three objectives of the developmental programs and investigations provided under this activity. These are (*a*) to develop systems of management of all types of radioactive wastes, (*b*) to establish technical criteria for disposal of radioactive effluents to the environment, (*c*) to obtain knowledge of fundamental

phenomena and processes in waste disposal. The program aimed at the realization of these objectives is divided into four areas as set forth below:

(*a*) Environmental investigations:

Fiscal year 1960	$1,150,000
Fiscal year 1961	1,325,000

These investigations involve a detailed evaluation of specific environments for the purpose of establishing rational technical criteria for safe dispersal of radioactive effluents into the environment. The increase in fiscal year 1961 is related to an expanded program of geophysical investigations at NRTS to obtain needed engineering data on ground disposal systems, expansion of oceanographic survey work on sea disposal areas and increased geohydrological studies in connection with regional land burial sites.

(*b*) Low and intermediate level waste studies:

Fiscal year 1960	$425,000
Fiscal year 1961	450,000

Provided for here are studies directed toward the development of improved systems for the handling, treatment, and disposal of low and intermediate level liquid wastes. The increase in fiscal year 1961 is related to work being performed at Hanford and represents the transition to field investigations of work previously done in the laboratory on the determination of ion exchange capacity and replacement reaction between minerals and certain radioisotopes.

(*c*) High level waste studies:

Fiscal year 1960	$1,280,000
Fiscal year 1961	1,420,000

Funds requested will provide for studies directed at the engineering development of practical systems for the safe ultimate disposal of high level radioactive wastes.

The increase requested for fiscal year 1961 will provide for additional effort related to the salt experiment at the Carey salt mine, expansion of Hanford effort on conversion of high level wastes to an oxide and extension of laboratory studies on thermite fixation techniques.

(*d*) Gaseous effluent studies:

Fiscal year 1960	$355,000
Fiscal year 1961	335,000

Provided for under this activity are studies directed toward the development of new and improved systems for treatment and control of gaseous and particulate effluents. The scope of work in this area will be continued at approximately the same level.

4. Merchant ship reactors, $8,300,000

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
(*a*) Pressurized water reactors	$1,747,320	$3,899,000	$4,700,000
(*b*) Maritime gas-cooled reactor	2,313,010	2,575,000	3,000,000
(*c*) Maritime boiling water reactor	287,161	750,000	0
(*d*) Supporting activities	309,379	500,000	300,000
(*e*) Advanced reactor studies	38,981	200,000	300,000
(*f*) Study of prototype reactor for nuclear tanker	0	750,000	0
Total	4,695,851	8,674,000	8,300,000

The objective of the nuclear merchant ship program is to develop economically competitive nuclear merchant ships and to secure their acceptance in unrestricted world commerce. To attain this goal, the Atomic Energy Commission is cooperating with the Maritime Administration in a joint developmental program which involves the adaption of technically proven reactor systems to several promising vessel types together with a longer range program aimed at the development of more advanced nuclear propulsive systems and optimum ship designs. The program also includes a variety of supporting activities aimed at

assuring that nuclear powered merchant ships may operate freely and safely in world commerce with a minimum of operating restrictions imposed because of their nuclear character. In carrying forward this program, the Commission has responsibility for the nuclear portion of the various projects; the responsibility of the Maritime Administration extends to conventional marine phases of the work.

(*a*) *Pressurized water reactors*

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
Total	$1,747,320	$3,899,000	$4,700,000
Research and development	1,747,320	1,800,000	3,035,000
Fuel fabrication	0	1,200,000	265,000
Test operations	0	899,000	1,400,000

The design, construction, and operation of the NS *Savannah* represents the major segment of the AEC–MA program. The vessel is in an advanced stage of construction, and startup and initial operation are currently scheduled for the spring of fiscal year 1960. The funds requested under this activity provide for the conduct of a research and development effort carried out in support of construction activities, the development and fabrication of improved and more economic nuclear plant components including cores, and for work related to the experimental operation of the vessel's nuclear plant. These various areas are briefly described below:

Research and development.—Oak Ridge National Laboratory is currently carrying out research and engineering activities related to the construction of the *Savannah*, including work in reactor engineering, metallurgy, health physics, etc.; the program includes the installation and operation of a water loop in the ORR. With completion of construction of the *Savannah*, ORNL, work will be directed toward the development and testing of improved fuels and components and analytical work relating to experimental operations of the *Savannah*'s nuclear plant. Irradiation of first core type fuel bundles will be continued into fiscal year 1961 in order to confirm designed life expectancy. The General Electric Co. is now completing design of a second core. While it embodies several substantial improvements over the first core, this second core is intended primarily for standby purposes to insure the continued operation of the *Savannah*. Development of a third core will be started in fiscal year 1961; the intent of this developmental work will be to achieve a core design which represents a major step forward from the first and second cores, and will provide a substantial improvement in operating costs. Consistent with this objective of improved operating economics, and with the President's directive for use of the *Savannah* as a floating laboratory, work is being initiated to develop improved nuclear plant components for use aboard the vessel. In fiscal year 1960, developmental and fabrication work will be started on improved control rod drive mechanisms, buffer charge pumps, instrumentation, etc.; in fiscal year 1961, fabrication of these items will be continued and installation and test aboard the vessel initiated.

Fuel fabrication.—Fabrication work on the second core was initiated late in fiscal year 1959, and is being carried forward on a schedule which will permit its delivery shortly after the initial criticality of the *Savannah*'s nuclear plant for standby purposes. The start of fabrication of the third core is now planned for the latter part of fiscal year 1961; this schedule is, of course, predicated upon the results of third core developmental work and actual operating experience with the first and second cores.

Experimental operation.—This estimate is developed in accordance with the agreement between the AEC and the Maritime Administration covering the operation of the *Savannah* for the 2 to 3 years during which she will be jointly operated as an experimental vessel. During this period, the AEC will, in general, assume the responsibility for all costs related to the operation of the nuclear plant. The estimate presumes an extensive period of tests and trials conducted by the shipbuilder and extending through the first quarter of fiscal year 1961. Provision is made for the assignment of the ship's crew to the vessel following completion of their training and prior to the initiation of tests and trials. It is

also contemplated that the vessel's operator will undertake engineering studies directed toward the solution of specific operating problems and the development of improved operating procedures.

(*b*) Maritime gas-cooled-reactor program:

Research and development:

Fiscal year 1959	$2,313,010
Fiscal year 1960	2,575,000
Fiscal year 1961	3,000,000

Presently available reactor technology makes it possible to develop marine nuclear propulsion plants which can be expected to approach economic competitiveness in specialized applications. The attainment of truly economic nuclear propulsion for a variety of maritime applications is, however, dependent upon the development of a highly efficient, lightweight compact plant which is largely self-regulating and ideally amenable to remote operation. Design and feasibility studies completed in fiscal year 1957 indicated that a nuclear propulsion plant consisting of a high-temperature glass-cooled reactor directly coupled to a closed-cycle gas turbine shows excellent promise for the attainment of this low-cost propulsive power objective.

Since the latter part of fiscal year 1958, the AEC and the Maritime Administration have been carrying forward a jointly financed developmental effort aimed at proving out this concept for merchant ship application. AEC responsibilities in the program center around the work associated with the development of the reactor and associated systems; the Maritime Administration has responsibility for turbine, compressor, and related auxiliaries. The reactor system under development is in the power range of approximately 50 megawatts (thermal); it will utilize helium as a coolant and will operate with a reactor gas outlet temperature of about 1500°. During fiscal year 1959, development centered mainly around various reactor core materials and coolants to arrive at an optimum design. The fabrication of a gas-cooled loop in a Hanford reactor was completed and assembly of a critical experiment was initiated. Preliminary design of reactor plant components and test programs to identify and resolve related engineering problems were well advanced. In fiscal year 1960, models of control-rod-drive mechanisms, reactor vessel, and emergency cooling system will be assembled for detailed engineering tests. Inpile testing of fuel and other materials in the Hanford loop will continue. In fiscal year 1961, the critical experiment facility will be completed and placed into operation. Test of models will be completed and the design features of major components will be established, and a powerplant simulator will be constructed to highlight control problems.

(*c*) Maritime boiling-water reactor:

Research and development:

Fiscal year 1959	$287,161
Fiscal year 1960	750,000
Fiscal year 1961	0

The work under this activity relates to the development of boiling-water reactor concept to commercial marine application. In fiscal year 1959, work was initiated on the resolution of specific engineering and development problems associated with the adoption of the boiling-water reactor system to marine use and preliminary design data for a 30,000-shaft-horsepower marine plant was developed. This design work was done using a 60,000 deadweight ton tanker as a reference vessel. In fiscal year 1960, engineering and developmental work will continue with emphasis being given to the attainment of design features which are specifically related to the seagoing application of the boiling-water reactor concept. Rather than being oriented toward a 30,000-shaft-horsepower plant, this work will be of general applicability and will be of value to any marine boiling-water reactor constructed in the future and to marine reactor technology in general. These investigations will deal with studies of stability and burnout, automatic control rod position systems, and internal steam separation/drying methods. As indicated below, the boiling-water reactor system will be evaluated along with other promising systems for tanker application; as a consequence, plans for continuing work on the boiling-water reactor

system into fiscal year 1961 have been deferred pending the outcome of the design study.

(*d*) Supporting activities:

Fiscal year 1959	$309,379
Fiscal year 1960	500,000
Fiscal year 1961	300,000

The introduction of nuclear merchant vessels in world commerce requires that a number of supporting activities and services be provided. International and domestic acceptance of nuclear ships is dependent upon the ability to assess and minimize potential environmental hazards resulting from their operation; specialized maintenance and repair procedures and facilities must be developed; licensed personnel already documented by the Coast Guard must receive specialized training in the operation of nuclear vessels; and operating rules and arrangements must be developed to satisfy both foreign and U.S. regulatory requirements.

Environmental and shipboard safety studies.—Since 1958, a program has been underway to develop current, tide, and salinity information for an analysis of the transport of fission products in harbors and estuarial waters. The information gathered through studies of typical harbor areas is extrapolated to other harbors of the world through the use of hydraulic models. Work is also underway to gather background environment information at Camden, N.J., where the *Savannah* is being constructed, and similar studies will be carried forward at other sites which will be utilized in the initial test operation of the *Savannah*. Work is also going forward on the development of equipment and methods aimed at insuring shipboard safety. Work is underway on the development of countermeasures for use against the accidental release of fission products. In fiscal year 1960, work will begin on radiation safety problems and procedures affecting passengers, crew, and cargo, utilizing as-built design data for the *Savannah*, safeguards analysis, and experience with the initial operation of the nuclear plant.

Analysis and design of shore facilities.—Nuclear vessels will, of course, require specialized facilities for maintenance, repair, and refueling. The AEC is developing the procedures for specialized maintenance and repair and preparing conceptual design data for required facilities. Maritime Administration is undertaking the actual detailed design and construction of facilities required initially to serve the *Savannah*. AEC developmental work related toward *Savannah* maintenance and repair work will extend through fiscal year 1960, and work will also be initiated in fiscal year 1961 on the maintenance and repair requirements for nuclear vessels utilizing other reactor systems.

Crew training.—The AEC has responsibility for providing on-the-job training in reactor operation to ship crews. Funds have been included in this estimate to provide for instruction at various AEC reactor sites.

Acceptance problems.—The international acceptance of nuclear-powered merchant vessels presents a wide variety of technical and nontechnical problems. The latter includes a variety of questions falling into the legal, regulatory, and nuclear and marine insurance fields. Work has already been started to identify these problems and more detailed investigations into specific problem areas are planned for fiscal years 1960 and 1961. Work is also underway to facilitate acceptance of nuclear ships by making available technical and nontechnical information to both regulatory groups and to the general public. In this connection, technical-documentary film footage relating to the operational phase of the *Savannah* project will be made.

(*e*) Advanced reactor studies:

Fiscal year 1959	$38,981
Fiscal year 1960	200,000
Fiscal year 1961	300,000

This activity provides for preliminary investigations and developmental work aimed at identifying those reactor systems which offer promise of lower costs and improved performance in marine application. It involves technical and economic feasibility studies of advanced nuclear systems having long-range potential, and preliminary engineering development for those systems showing promise for early application in merchant ships. This work parallels a Maritime Administration funded effort on promising nuclear ship designs.

Feasibility studies.—Work will be carried forward in fiscal years 1960 and 1961 on the analysis of various reactor systems and component improvements to determine their applicability to advanced nuclear ship designs such as a large submersible, surface effects concept, etc. Emphasis will be placed on lightweight, compact reactor systems which will be to a large degree self-regulating and susceptible to remote operation.

Engineering development.—Work in this area will be aimed at those reactor systems which are now in a relatively advanced state of development and can be adapted to marine purposes with a limited amount of developmental work. Consideration will be given to engineering problems associated with the application of various reactor systems to specific vessel types. Studies will be made of small plants (5,000 to 10,000 shaft horsepower) for dry-cargo or specialized vessels, and large plants (35,000 to 40,000 shaft horsepower) including multiple reactor designs for very large tanker or liner application.

(*f*) Study of prototype reactor for nuclear tanker:

Fiscal year 1959	0
Fiscal year 1960	$750,000
Fiscal year 1961	0

Section 113 of the fiscal year 1960 authorization act directs the AEC to undertake a design study of a prototype plant suitable for use in a nuclear tanker. Engineering and economic evaluations will be made of both the direct- and indirect-cycle boiling-water systems and the advanced pressurized water concept. These evaluations are being made in terms of a single reference vessel of 45,000 deadweight tons by the Maritime Administration. A comparison and evaluation of each of these studies is being made by the Division, assisted by the Oak Ridge National Laboratory on a schedule consistent with April 1, 1960, reporting requirements specified by the Joint Committee on Atomic Energy.

5. Army power reactors, $15,000,000

The objective of the Army power reactors program is the development of a family of reactor systems to fulfill military requirements for nuclear powerplants for use in remote areas and for unique military purposes. To meet this objective all reactor concepts which show promise of fulfilling military requirements must be studied and evaluated. Four general reactor concepts are under development into military reactor systems: (1) pressurized water reactors; (2) boiling-water reactors; (3) gas cooled reactors; and (4) fast reactor systems.

Army power reactors	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
(*a*) Army package power reactors	$1,514,781	$1,523,000	$1,900,000
(*b*) Stationary low powerplant No. 1 (SL-1)	661,613	600,000	900,000
(*c*) Gas-cooled reactor systems	6,305,972	6,000,000	7,000,000
(*d*) Military compact reactors	341,858	1,000,000	4,000,000
(*e*) General support	160,710	820,000	1,200,000
(*f*) Advanced reactor studies	25,017	500,000	0
(*g*) Study of reactor at remote site	0	515,000	0
Total Army power reactors	9,009,951	10,958,000	15,000,000

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(*a*) Army package power reactors	$1,514,781	$1,523,000	$1,900,000
(1) Stationary medium power reactor No. 1, SM-1 (formerly APPR-1)	516,743	333,000	300,000
Research and development	368,420	183,000	300,000
Test operation	148,323	150,000	0

The objectives of the SM-1 research and development program are to improve plant reliability and reactor system component lifetimes; to extend the knowledge of reactor performance characteristics; and to provide basic and advanced knowledge and data applicable to pressurized water, stainless steel clad, highly enriched fuel nuclear powerplants such as the SM-2, SM-1A, PM-2A, and the

PM–2, now being planned, designed, and constructed as a part of the Army nuclear power program.

The effort for fiscal year 1960 includes research and development on core performance, fission product analysis, activity buildup, and decontamination of the primary system. Core II will be installed and the development of core III will commence. In fiscal year 1961, in furtherance of the above objectives, research and development on activity buildup and fission product analysis will continue. In addition, core II performance will be evaluated with the knowledge and data gained to be applied to the core III development and fabrication program. The major portion and completion of the core III development program will occur in fiscal year 1961. A series of special tests in the areas of plant chemistry, radiochemistry, core parameters, shielding studies, instrumentation and controls, heat transfer and flow, system tests, mechanical components, and health physics will be scheduled, conducted, and analyzed to provide technical support by developing applicable areas of pressurized water reactor technology for the field plants of the Army nuclear power program. Test operation costs will be shared with the DOD through fiscal year 1960; in fiscal year 1961 the DOD will fund completely for operation of the plant.

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(2) Stationary medium powerplant No. 2, SM–2 (formerly APPR–1B)	$969,058	$1,000,000	$1,000,000
Research and development	969,058	1,000,000	650,000
Fuel fabrication	0	0	350,000

This program is directed toward the development of a core and related structure capable of operating at approximately a 28 thermal megawatt power level for 1 year. The core will be designed for a net six electric megawatt DOD plant. The fiscal year 1960 efforts will include completion of the primary critical experiment; the conduct of critical experiments on the reference design; performance of nuclear, thermal, and hydraulic design analysis; insertion of fuel samples for irradiation testing; metallurgical development and pressure vessel design; and completion of the core mechanical design. In fiscal year 1961 the design analysis of the core will be completed; the irradiation test results evaluated and materials selected; core fabrication development completed; core procurement started; and specifications for testing the core will be prepared.

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(3) Portable medium power plant No. 1, PM–1 (formerly APPR–2)	$28,980	$190,000	$600,000
Research and development	0	0	500,000
Fuel fabrication	28,980	190,000	100,000

The factory prepackaged plant, constructed in modules to enable rapid field erection and relocation, is being designed, developed, and constructed under a joint AEC–AF funding arrangement. During fiscal year 1960, core fabrication will be initiated. In fiscal year 1961 the core will be completed, a program for plant performance testing will be planned, improved plant components will be developed, the plant will be analyzed to determine performance limits, and technical support for installation and operation will be provided.

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(b) Stationary low power plant (SL–1)	$661,613	$600,000	$900,000
Research and development	453,473	295,000	360,000
Fuel fabrication	16,654	0	225,000
Test operations	191,486	305,000	315,000

During fiscal year 1960 plant operation and test will continue to determine the limits of performance of the plant and to obtain performance and design data from the plant and core to be applied toward improvement of the present plant and toward the development of a portable, preassembled, air-transportable plant. In addition, effort will be made to determine deficiencies in the present design and to make the modification necessary to correct such deficiencies. During fiscal year 1961 plant operation and testing will continue with the above objectives. In addition, a replacement core will be designed and procured. Development of a preassembled, modular plant will be initiated.

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(c) Gas-cooled reactor system	6,305,972	$6,000,000	$7,000,000
Research and development	2,866,271	4,425,000	3,950,000
Fuel fabrication	586,169	950,000	555,000
Test operations	0	575,000	2,050,000
Experiment fabrication	2,853,532	50,000	445,000

The objective of this program is to develop a mobile, trailer-mounted, nuclear powerplant to meet a requirement of the DOD. In fiscal year 1960 work will include core and shield development for the water moderated ML–1, core development for the solid moderated GCRE–II system and testing of components in shock and under extreme environmental conditions. A second core for the GCRE will be fabricated in fiscal year 1960, and fabrication of the ML–1 core will be initiated. The GCRE will be completed and operated for two quarters. During fiscal year 1961 research and development will continue on the ML–1 core with primary emphasis on testing of elements in and out of pile. The solid moderated core development will continue to the point of design of the core and reactor vessel. The ML–1 core will be completed and fabrication of a second core will be initiated. The GCRE will be operated for the entire year and the ML–1 for one quarter. Procurement specifications for military field units of the ML–1 type will be initiated.

(*d*) **Military compact reactors:**

Fiscal year 1959	$341,858
Fiscal year 1960	1,000,000
Fiscal year 1961	4,000,000

In fiscal year 1961 the principal effort will be directed toward system and component development of the compact reactor.

Additional information of a classified nature is presented on classified page 118.

(*e*) **General support:**

Fiscal year 1959	$160,710
Fiscal year 1960	820,000
Fiscal year 1961	1,200,000

Funds in this activity are required to cover the cost of (1) operation of the hot cells and shop and maintenance building at the Army reactor experimental area, (2) services provided by the National Reactor Testing Station operator, (3) general research and development support of the Army program by the Oak Ridge National Laboratory, (4) operation of the nuclear test plant, a full-scale core test facility to test Army field plant cores prior to actual use, and (5) development of commuter codes for use in nuclear design and analysis of pressurized water cores.

(1) Area support facilities:

Fiscal year 1959	0
Fiscal year 1960	$50,000
Fiscal year 1961	350,000

The hot cells and shop and maintenance building to be completed late in fiscal year 1960 will be operated in support of the Army reactors located at National Reactor Testing Station, Idaho.

(2) NRTS services:

Fiscal year 1959	0
Fiscal year 1960	50,000
Fiscal year 1961	300,000

Increased activities in the Army reactors program at the National Reactor Station, Idaho, will result in increased services, i.e., health and safety, communication, fire protection, security, transportation, etc., and appropriately higher allocations of charges therefor.

(3) ORNL:

Fiscal year 1959	$160,710
Fiscal year 1960	200,000
Fiscal year 1961	125,000

The effort in fiscal year's 1960 and 1961 will be devoted to advanced research and development on reactor technology, primarily in the field of metallurgy at ORNL, for application to mobile and portable power reactors.

(4) Nuclear test plant (NTP):

Fiscal year 1959	0
Fiscal year 1960	$220,000
Fiscal year 1961	250,000

Conceptual design of the NTP, a full-scale core test facility to test Army field plant cores prior to actual use thus obviating the necessity for prototype plants, will be completed in early fiscal year 1960. In addition site survey and selection will be completed, the detailed design will be reviewed, and specifications for selected equipment will be prepared. In fiscal year 1961 the construction work will be monitored, technical and engineering services in support of construction performed, a core-testing program for the SM-2 prototype core planned and coordinated, and initial test operation of the facility conducted.

(5) Code development:

Fiscal year 1959	0
Fiscal year 1960	$300,000
Fiscal year 1961	175,000

This is a program to develop digital computor codes and programs for use in nuclear design and analysis of pressurized water cores to obtain longer life, greater economy, reduced flow and pressure requirements, and better control. In fiscal year 1960 a literature survey will be completed and the selection, evaluation and verification of applicable available codes made. In fiscal year 1961 codes will be further verified on actual core operating data.

(*f*) Advanced reactor studies:

Fiscal year 1959	$25,017
Fiscal year 1960	500,000
Fiscal year 1961	0

These studies have included the continuous evaluation of advanced reactor concepts to determine adaptability of results to package reactor systems for foreseeable lang-range requirements . No studies are contemplated in fiscal year 1961.

(*g*) Study of remote military power:

Fiscal year 1959	0
Fiscal year 1960	$515,000
Fiscal year 1961	0

The study of remote military power applications being conducted in response to a directive contained in the fiscal year 1960 authorization act will be completed in fiscal year 1960.

6. Naval reactors, $85,000,000

The objective of the naval reactors program is the development of naval nuclear propulsion plants and reactor cores in a wide range of power ratings to meet military requirements specified by the Department of Defense. The pressurized water nuclear propulsion plants and cores under development by the Atomic Energy Commission are suitable for installation in Navy ships ranging from small submarines to large combatant surface ships. The level of the naval program of the Atomic Energy Commission in fiscal year 1961 is approximately the same as in fiscal years 1959 and 1960. Emphasis continues on the research, development, and design of pressurized water reactor cores of improved design and longer life. The test operation and evaluation of naval reactor prototype plants and cores and the operations of special development test facilities also will continue. Construction of a natural circulation test plant will be underway and initial test operations of the destroyer reactor prototype plant are scheduled to begin.

Additional information of a classified nature is presented on classified pages 118 through 130.

7. Airplane propulsion reactors, $73,000,000

The airplane propulsion reactors program is directed toward the development, fabrication, and testing of nuclear reactors and associated components, and their integration into aircraft nuclear propulsion systems. The development of turbomachinery and other Air Force oriented components of the propulsion system is being performed under Department of the Air Force contracts.

Additional information of a classified nature is presented on classified pages 131 through 135.

8. Missile propulsion reactors, $43,300,000

The objective of the missile propulsion reactors program is to demonstrate the feasibility of nuclear reactors for application to ramjet and rocket propulsion systems.

The fiscal year 1961 program will continue the research and development effort and provide for fabrication leading to the operation of additional experimental reactors at the Nevada test site.

Additional information of a classified nature is presented on classified pages 135 through 139.

9. Satellite power sources, $14,000,000

This program is directed toward the development, fabrication, and testing of small, lightweight package-type auxiliary power systems utilizing nuclear-derived heat radioisotopes and compact reactors. The SNAP III program to develop small inexpensive proof-of-principle nuclear-powered devices with unique conversion techniques will continue. The initial unit in this program, a 5-watt model producing electric power by means of thermoelectric converters, was demonstrated in fiscal year 1959.

Additional information of a classified nature is presented on classified pages 140 through 145.

10. Operational services, $1,000,000

Included in this category are the nondistributed costs of the materials testing reactor, and engineering test reactor, and the operation of the National Reactor Testing Station, and such other costs as startup and standby, and transportation and security shipments.

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
(*a*) Operation of test reactors	$1,554,585	0	0
(*b*) Operation of National Reactor Testing Station	214,588	$352,000	$550,000
(*c*) Startup and standby costs	1,338,073	136,000	150,000
(*d*) Transportation and security shipments	145,320	180,000	300,000
Total	3,252,566	668,000	1,000,000

(*a*) Operation of test reactors:

Fiscal year 1959	$1,554,585
Fiscal year 1960	0
Fiscal year 1961	0

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Materials testing reactor:			
Gross cost of operation	$3,958,030	$4,400,000	$4,460,000
Less irradiation services to other programs	3,958,030	4,400,000	4,460,000
Net cost	0	0	0
Engineering test reactor:			
Gross cost of operation	4,273,163	5,400,000	5,800,000
Less irradiation services to other programs	2,718,578	5,400,000	5,800,000
Net cost	1,554,585	0	0

The materials testing reactor and the engineering test reactor operate to provide high flux for research purposes for various AEC contractors, AEC-sponsored and public groups in the study of radiation damage; to assist with fundamental research on transuranic and other elements; to aid in the development of fuel elements for various types of reactors; to produce isotopes; and to provide a source of neutrons for cross-section measurement work. The cost of these services is charged to users of the services, and there are, therefore, no costs shown here. In fiscal year 1959 the ETR was not fully utilized for the whole year due to loop installation work. As a result, a net cost of $1,554,585 for fiscal year 1959 was not distributed to using programs.

(b) Operation of national reactor testing station:

Fiscal year 1959	$214,588
Fiscal year 1960	352,000
Fiscal year 1961	550,000

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Gross cost of operation	$5,844,164	$6,280,000	$6,690,000
Less distribution credits	5,629,576	5,928,000	6,140,000
Net cost	214,588	352,000	550,000

This activity is for operating and maintaining the national reactor testing station. The costs are distributed to the programs using the services of the station. The increase in operating costs is for related communications, health and safety and transportation costs and additional advanced general site planning. The advanced general site planning includes such items as: underground water studies; aggregate investigation, halogeton control, and grazing claims.

(c) Startup and Standup Costs:

Fiscal year 1959	$1,338,073
Fiscal year 1960	136,000
Fiscal year 1961	150,000

This activity provides for the startup and standby of certain special reactor materials production facilities and related termination costs. In fiscal year 1959 costs were for partial termination of beryllium contracts plus a small amount of yttrium standup costs. Fiscal year 1960 costs will be incurred for beryllium and yttrium plants standby and startup.

(d) Transportation and security shipments:

Fiscal year 1959	$145,320
Fiscal year 1960	180,000
Fiscal year 1961	300,000

This estimate is for coordinating, escorting and providing armed protection for shipments of highly classified materials and documents, as well as materials that cannot be transported by common carrier because of health and safety hazards.

11. Equipment not included in construction, $21,800,000

Equipment requirements for the reactor development program are estimated at $21,800,000 for fiscal year 1961. This requirement is to support the continuing program for development of civilian and military reactors. There fol-

lows a breakdown of the equipment requirements estimated for each operations office.

Operations office	Estimate of other operating costs, fiscal year 1961	Estimated equipment costs, fiscal year 1961
Chicago	$62,710,000	$3,900,000
Idaho	24,315,000	1,500,000
Lockland	66,925,000	4,700,000
New York	12,756,000	700,000
Pittsburgh	53,840,000	4,700,000
Schenectady	46,873,000	1,500,000
Oak Ridge	30,945,000	1,300,000
Savannah River	12,250,000	200,000
Albuquerque	29,090,000	1,800,000
Hanford	7,855,000	800,000
San Francisco	30,854,000	700,000
DRD—Headquarters	35,987,000	0
Total	414,400,000	21,800,000

ABANDONMENT OF ADDING GENERATING CAPACITY AT SHIPPINGPORT

Mr. CANNON. Last year we had some discussion about setting priorities for power reactor concepts in terms of those most likely to achieve the economically feasible electric power in the shortest time. You have been working on that; we have been discussing that. I believe we asked you to include that in the record. What has happened to the idea that the power company could add generating capacity at Shippingport?

Dr. PITTMAN. The studies that we made since last year, Mr. Cannon, to determine the economic feasibility of Duquesne adding roughly 50 megawatts of additional capacity have indicated to the satisfaction of both Duquesne and ourselves it is not economically feasible. The cost of adding generating capacity alone is so high that the cost of the reactor would not be economical.

Mr. CANNON. For the time being you have abandoned that idea?

Dr. PITTMAN. Yes, sir; we plan to go on to increase the power of the reactor but to dump that heat rather than to generate electricity.

Mr. CANNON. The idea here is that the Government will pay this cost instead of the Duquesne Power Co. What is the situation there?

Dr. PITTMAN. The situation is that we will generate no electric current with the additional steam that is produced from this core that we are placing in the Shippingport reactor. The power that is produced will be made into steam which will be dumped in the so-called steam dump. We have in this year's authorization budgeted for this $4 million additional construction.

Mr. CANNON. The idea is then that the Government, rather than the Duquesne Co., will bear the burden.

Dr. PITTMAN. Yes; the Government will bear the additional cost.

Mr. CANNON. What is the cost?

Dr. PITTMAN. Estimated at $4 million, sir—dumping the steam for the 50 megawatts.

Mr. CANNON. Is that a continuing expense?

Dr. PITTMAN. No. That is a nonrecurring construction expense. It is in our construction budget, sir.

Mr. CANNON. Mr. Jensen.

Mr. JENSEN. Is the record of operation of the Shippingport plant such as to enable it to operate to furnish dependable capacity to Duquesne Light Co. or has it been more of a dump-power proposition with the utility not being able to depend on the Shippingport capacity at time of system peak demand?

Dr. PITTMAN. The Shippingport reactor, sir, was built with the idea that it would be a developmental power reactor, with the emphasis initially on the developmental aspects of the operation of that reactor. It is not meant to be on steam for a continuing period of time to meet a high load demand. The whole purpose of this reactor is that it is a very highly instrumented reactor from which you can get extremely valuable information that can be used in the construction of future reactors. It has in its operation furnished such information. It is the only reactor to date that has given us the statistical operating information about fuel, for instance. So that, in answer to your question, it is not used by the Duquesne Co. as a demand-type reactor.

Mr. JENSEN. It has little value in that respect to the Duquesne Co.?

Dr. PITTMAN. I would not say it is of little value, sir. It was planned in their system at the time they integrated it into the system that it would necessarily be on the line 80 to 90 percent of the time. I believe it has been on about 40 percent of the time.

Mr. JENSEN. You can't depend on it?

Dr. PITTMAN. It is not a question of dependability, because of the failure of the reactor to operate. It is because we wish to get information and, therefore, we shut the reactor down and start it up and run it through its paces as a developmental tool.

Mr. JENSEN. Is this the reason we are told——

Dr. PITTMAN. No, sir; I think the primary reason is that the cost for the additional generating capacity is of the order of roughly $24 million. This includes not only the generating capacity, but the lines necessary to get it from the Shippingport site to the area where they need the capacity. They do not need the power in that particular area. There is about $4 or $5 million worth of transmission lines that would have to be built. So the combination of the transmission lines, plus the somewhat expensive turbine generator equipment that is necessary for this saturated steam equipment, steam produced at Shippingport has made it uneconomical to generate the current.

Mr. CANNON. Could the Duquesne people put in additional generators and utilize the steam and save the Government from the expense of the sink? We gave them a differential. We gave them a special rate. It looks as if we have catered to the Duquesne people there at our expense. Why didn't the Duquesne people build this additional generator?

Dr. PITTMAN. The Duquesne people have put into the Shippingport facility on the order of $20 million already for the conventional equipment that is in there.

Mr. CANNON. They got value received, did they not?

Dr. PITTMAN. They are. The additional $20 million for the 50-megawatt power to be generated—if you just take the capital cost alone, it would be completely uneconomical to generate the power.

Mr. CANNON. They could utilize the steam. We gave them a special rate on the steam. Why should they not go ahead and put in a generator and save us from the heavy expense of the sink?

Dr. PITTMAN. Even if we gave them the steam for no charge at all—and they are paying at this time about 8 mills per kilowatt-hour for the steam they are buying from us at this moment—but if we gave them the steam for essentially zero mills per kilowatt-hour for the steam, just amortizing the cost of this $20 million for the 50 megawatts of power that will be produced is too expensive a proposition.

Mr. CANNON. We could have very well given them the steam if it would have saved us from the expense of the establishing of the sink.

Dr. PITTMAN. I say, even if we gave it at essentially a half mill a kilowatt-hour, it would be uneconomical. It will not pay for itself under any conditions we have figured out.

Mr. CANNON. Isn't this really a failure on the part of the company to carry out an agreement they had with us? It was part of the original plan that they should utilize the steam; that it would not be necessary for us to construct this sink. Apparently they have fallen down on their agreement.

Dr. PITTMAN. No, sir. They put in enough capacity to take the reactor to 100 megawatts. The capacity was initially 60. The Duquesne Co. did put in capacity to go to 100 megawatts. The original agreement was based on their taking the steam up to that. The contract calls for them paying 8 mills per kilowatt-hour for this steam that comes out of the reactor up to this 100 megawatts. Their contract was for a fixed period of time. There was no commitment on their part to go forward beyond that at the same price and there was no commitment, implied or otherwise, with regard to increasing power beyond this 100 megawatts.

Mr. CANNON. Why did we let this time limit expire? Why didn't we go ahead and insist on provision being made to carry out the contract.

Dr. PITTMAN. Our contract had no provision for having them put on the additional 50 megawatts. They have already put the 100 megawatts on. Our present capacity at Shippingport is 100 megawatts. The present core goes to 60 megawatts. We are replacing that core in a way that it will be possible to go to 150 megawatts equivalent electrical power. There is no contractual relation that would in any way obligate them to put the additional power on. And then it just is uneconomical for them to do so, and I think in no way have they reneged on their contract.

Mr. CANNON. If Duquesne refuses to take this steam, is there some other disposition that could be made of it? Is there some other market for it? Could the steam or heat be marketed elsewhere, or otherwise?

Dr. PITTMAN. One of the main reasons that Duquesne cannot use this power economically is that the need for power on their system is not at that particular location. They would have to transport the power over powerlines to some more distant area, and there is no other utility company in the area that can use that. The cheapest way for

us to get rid of the heat, the extra heat that is generated, is to dump it.

Mr. CANNON. That was an expense which we had not anticipated.

Dr. PITTMAN. It was an expense which at the time we went into it we wanted to investigate with Duquesne, if possible, generating the electrical current.

Mr. CANNON. But we took for granted that Duquesne would utilize all steam available.

Dr. PITTMAN. With the $5 million in last year's budget we were anticipating we would try to negotiate with them to try to take this power.

Mr. MCCONE. The Commission appointed a special committee to go into this matter. It happens that Dr. Wilson who is now a Commissioner was a member of that committee. He may have some remarks he would like to make. I would like to give him an opportunity.

Mr. CANNON. Dr. Wilson, we shall be glad to hear from you.

Dr. WILSON. I think it should be made clear that the Duquesne Power Co. lived up to everything that could be expected of them. They are actually going to take a lot more steam than they have from the present core. They are going from 60 to 100 megawatts with their existing installation. Now, it is the extra 50 megawatts that they will not be able to take, and they do not want to install the generating equipment for that because we can't give them assurance of operating that for any great period of time. Some time the day will come when we have these other powerplants going that we will want to shut down Shippingport. Actually its cost is very high. Duquesne Light was in the position that they were willing to make an agreement for paying for steam for 20 years if we were willing to give them the steam, but if we should cut down the plant in 5 more years, we would have to pay three-quarters of the cost of the extra generating capacity, which we did not want to take the obligation for the Government. Therefore, it really looked to us as though it was the cheapest way for us to get out and that Duquesne Light was doing everything that could be expected under their contract or even wiling to go the second mile. But obviously with poor quality steam, intermittent operation, and a serious question as to whether we would want to operate it for 20 years which you ordinarily use to pay off generating equipment, it just was not economical. To protect themselves they would have had to put it back on us, on the Government, if we should down the plant before the 20 years were out.

AMERICAN STANDARD CO. STUDY

Mr. CANNON. Here is another proposition which we had not anticipated. You contracted a study with the American Standard Co. on the variable moderator reactor. I don't recall hearing of this plan before. Just what is involved?

Dr. PITTMAN. This is one of a series of studies that we make each year, sir, on the possibilities of new ideas having some economic feasibility in the future reactor development program. The varied moderator reactor is one in which the control of the reactor is by variation of the level of the moderator that is in the reactor. It uses water as a moderator, and you control the level rather than running

in and out the control rods. It is a simpler method of control. This is a study which the American Standard people started last year.

Mr. CANNON. What time will be required for this study?

Dr. PITTMAN. Could I ask Mr. Aebersold?

Dr. AEBERSOLD. I don't know.

Dr. PITTMAN. It is the order of 6- to 8-month study, sir.

Mr. CANNON. What results are you achieving in the work on nuclear superheat?

Dr. PITTMAN. Nuclear superheat is going along quite well. We have programs at several places underway. The Northern States power reactor has been modified to make it so that it can be constructed as a nuclear superheat reactor. The bonus reactor is built under second round conditions in Puerto Rico which is a superheat reactor. It looks encouraging to us.

In addition to that we have studies underway with both the General Electric Co. and the Combustion Engineering Co. to develop the study of the possibilities of developing nuclear superheat and the Borax V reactor, which is coming in under construction, will be a nuclear superheat reactor.

The CHAIRMAN. The committee will stand adjourned.

WEDNESDAY, APRIL 20, 1960.

AFTERNOON SESSION

Mr. RABAUT. The committee will come to order.

COOPERATIVE PROGRAM WITH CANADA

What do you expect to gain from the cooperative program with Canada on heavy water reactors? What are the financial arrangements on this work? Do you want to answer that, Mr. McCone?

Mr. MCCONE. I think it is best that Dr. Pittman, the Director of Reactor Development, answer that question.

Mr. RABAUT. Dr. Pittman.

Dr. PITTMAN. The program we are anticipating with the Canadians ties in with the fact that they and we are both carrying out at this time developmental work in the field of heavy water moderated natural uranium reactors. The Canadians are building a small 20-megawatt reactor in Canada now, and have approved and are starting construction on a 200-megawatt power-producing reactor of this heavy water natural uranium type. The work they have done in their laboratory and the work they will be doing to construct this large-scale reactor and operate the large- and small-scale reactors will be of great value to us and to them in the development and use of heavy water reactors.

In turn, the work we are doing in this country on the several smaller scale reactors will be used in this cooperative program. The way we plan to carry this out is a cooperative basis, and we have asked for the authorization to spend $5 million on research and development effort to assist in certain specific items that we can do better in this country for the so-called CANDU reactor which is the 200-megawatt reactor in Canada.

The Canadians, for several years have been interested in the heavy water field. Their scientists and engineers are extremely capable in this field, and the cooperative program will be of much benefit to our program.

Mr. RABAUT. There is no funding in this budget, is there?

Dr. PITTMAN. The authorization bill provides $5 million.

Mr. RABAUT. $5 million authorized?

Dr. PITTMAN. Yes. The program is a 3-year program.

Mr. RABAUT. So this amount of money extends over a 3-year period?

Dr. PITTMAN. Yes. The annual amount that would be spent will show in the heavy water program. The heavy water budget for fiscal year 1961 amounts to $8 million.

Mr. RABAUT. I thought you said $5 million?

Dr. PITTMAN. $1.5 million in fiscal year 1961, sir, for the cooperative program with Canada out of a total program of $5 million covering a 3-year program.

Mr. RABAUT. Is that the amount you need in 1961?

Dr. PITTMAN. For this program; yes, sir.

Mr. RABAUT. When do you expect to get into the actual construction of the experimental organic-cooled reactor?

Dr. PITTMAN. The organic-cooled reactor is the one we will build at Idaho. We expect to start construction some time this year. We are working on the design now.

FAST BREEDER REACTOR

Mr. RABAUT. Last year you said EBR–II would be in operation in May of this year. Now, you say it won't be operable until December.

Dr. PITTMAN. That is right, sir.

Mr. RABAUT. Why this slowdown?

Dr. PITTMAN. There have been many causes of delay, primarily associated with field construction problems. For example, the steel strike delayed delivery of a major piece of equipment which was required for installation of other equipment. Some delay also may have been caused by modifications of design to take advantage of the latest information that we have learned on the experimental breeder development program. We expect it to go critical in the latter part of this year.

Mr. RABAUT. The results of the study with this reactor would have some relationship to the Fermi reactor at Monroe, Mich.?

Dr. PITTMAN. Yes, sir.

Mr. RABAUT. We were kind of anxious that this get on the line.

Dr. PITTMAN. We are anxious that this get on the line, too, because it is an extremely important part of our fast breeder program. We are doing everything possible to push the schedule as fast as we can.

Mr. RABAUT. This is a fast breeder reactor, is it not?

Dr. PITTMAN. Yes, sir.

Mr. RABAUT. Is this delay going to slow down the Monroe project?

Dr. PITTMAN. No, sir. The Monroe project has had some problems with its core, the fuel structure, and they also are expected to have some delay. It will probably be early in 1961 before the Fermi reactor goes into operation. This delay will not in any way affect them in any event, even if they had not had that delay. The information

that comes from this reactor and the Fermi reactor tied together will give us information on the fast breeder system. Operation of EBR–II does not have to precede operation of the Fermi reactor.

SODIUM REACTOR EXPERIMENT

Mr. RABAUT. Please explain the significance of the recent fuel element failure in the sodium reactor experiment, and tell us why any further work on sodium-type reactors should not be limited strictly to fast breeder development work.

Dr. PITTMAN. The fuel failure on the sodium reactor experiment had nothing to do with the fact that it was a sodium-cooled graphite moderated reactor, and it in no way should indicate that that system should be stopped. It was caused by some contamination that got into the sodium. This liquid sodium is the coolant that takes the heat out of the reactor core. There was an organic material used to cool seals in one of the pumps. That organic material got into the sodium and decomposed, forming some solid pieces that plugged up the flow.

Mr. RABAUT. So it was not the fact that it was sodium?

Dr. PITTMAN. It was foreign matter in the sodium. We have immediately taken steps to assure that no such foreign matter will get into the Hallam reactor. Actually, in our program for the sodium-cooled system we are deemphasizing the sodium-cooled graphite moderated reactor and emphasizing the fast reactor systems, because, on the basis of our present analysis, it looks like everything that can be gained from the sodium system, namely, the high temperature and therefore efficient operation, can be gained in the fast breeders.

In addition, the fast breeder reactors have the possibility of breeding. Therefore, our major emphasis is planned to be put on the fast reactor system. You will notice in the budget there was a de-emphasis on the sodium graphite systems.

VARIATIONS IN ALLOCATION OF APPROVED PROGRAMS

Mr. RABAUT. You know, this Fermi reactor is out in my area, and I go out there quite often. The amount allocated to gas-cooled reactor development work for 1960 was $9.5 million. Now you are showing expenditures of $11.5 million for 1960. The committee is glad to see this concept expedited, but this is one more example of the variations between your budget estimates and actual allocation.

Further along this same line you estimate the Kaiser contract cost at $2.1 million for 1960. Now you show it as only $1 million. What plans do you have for making your budget figures more realistic?

GAS-COOLED-REACTOR PROGRAM COSTS

Mr. PITTMAN. The situation on this particular matter, sir, is that we have found in trying to push the gas-cooled-reactor program, because of its importance to the long-range development of economic nuclear power, that we were able to do more work in a shorter time than we had previously anticipated at the time the budget was prepared, at the time we talked to you last year. All of this work that can be done is work that is valuable to the rapid progress of the pro-

gram. The fact that the Kaiser program changed somewhat is because of the relocation of the effort or the determination to locate the effort at Oak Ridge and bring in the Carbide people. It is a shift in the amount of work that the Kaiser people would be doing versus the Carbide people.

Mr. RABAUT. That was all on gas cooled.

Dr. PITTMAN. All on gas cooled, yes, sir.

The problems of trying to predict a year to 2 years ahead of time on the exact amount of expenditure on the research and development program are quite difficult. We do the best we can on predicting.

Mr. RABAUT. That is about 50 percent out of the way.

Dr. PITTMAN. Yes. That was a reallocation. That was part of the increase that went to Carbide's phase of the work.

THERMAL BREEDER PROGRAM

Mr. RABAUT. Last year you budgeted $7.5 million for the thermal breeder program. The House specifically reduced this to $5 million. The conference action indicated a possible restoration of part of the cut. Now you show that you are going to spend $8.5 million on this program in 1960. I ask why?

Dr. PITTMAN. The situation with regard to the thermal breeder program is that when we talked to you last year there were three specific concepts considered under the thermal breeder program: aqueous homogeneous, molten salt, and liquid-metal-reactor systems. At that time we had indications that the aqueous homogeneous was the only one of the three that seemed to have promise for breeding or high conversion ratios. However, there were studies underway that would more accurately determine whether the others had any future.

We indicated that the liquid-metal-cooled reactor system could be closed out. It turned out, however, that the closing out of the liquid-metal-cooled system was not something that we could accomplish before 1960, and $1.5 million has been necessary in the closeout of the liquid-metal-cooled system in 1960.

The studies that we have been carrying out, and we have gotten preliminary reports as recently as March, and continuing studies, indicate that the molten salt reactor system, while not as good a breeding system as the aqueous homogeneous system, does have a high conversion ratio. It does not quite make more than it burns, but it has a high conversion ratio. It offers potential economics that we feel are worthy of continuing studies.

Mr. RABAUT. You are confirming then what you have here in your justification, that you are going to discontinue that?

Dr. PITTMAN. We are discontinuing the liquid-metal-cooled reactor.

Mr. RABAUT. What about the molten salt?

MOLTEN SALT REACTOR EXPERIMENT

Dr. PITTMAN. I feel right now, sir, that the molten salt does offer enough possibilities that we will probably want to give serious consideration to a reactor experiment in that field.

Mr. RABAUT. Since none of the fluid concepts are judged to be of reasonable potential, will you please explain to the committee why

we cannot drop this thermal breeder program and use the money on something more worthwhile?

FLUID FUEL SYSTEMS

Dr. PITTMAN. The fluid fuel systems do offer a potential advantage in that if an adequate fluid fuel system, and molten salt is one of these, can be developed it will offer the advantage that you do not have to go through the fabrication of solid fuel elements for these reactors. The continuation of a fluid-fuel program and a thermal breeder program is in our opinion necessary, because it is one promising way that you can use thorium as a raw material in the long run. We feel that the use of thorium as a potential raw material is something that we have to continue to study as a long-range possibility.

Mr. RABAUT. Now, why should we not drop it and do something else with the money?

Dr. PITTMAN. I think, sir, to drop a system, to drop studies——

Mr. RABAUT. Have you discovered anything new?

Dr. PITTMAN. Yes, I think we have discovered something in the fluid-fuel system, particularly in the molten salt system, that would indicate that if we are not looking actually for breeding but for high conversion ratios, and the fact that you can get high temperature from a molten salt reactor means that it has a potential for economic possibilities. The aqueous homogeneous system is the main one that offers potential for breeding in the thorium U^{233} system.

Mr. RABAUT. In the report to the Commission of December 1958 an ad hoc committee on reactor policies and programs recommended that the fluid-fuel concepts be critically evaluated and work concentrated on the concepts that appear most promising. Subsequently a task force of outstanding scientists and engineers was convened to make this technical evaluation and comparison in January 1959. The findings of the task force were used to evaluate each of the fluid fuel concepts in terms of its potential for meeting the objectives of the national civilian power reactor program. It was concluded that, first, none of the fluid-fuel concepts can meet the short-term objectives of achieving competitive power costs in the United States in 10 years, or in foreign countries in 5 years; second, that none of the fluid-fuel concepts are potentially attractive for reducing power costs over a long range based upon task force estimates of power costs for 30-megawatt-electrical stations and of the research and development programs required to achieve technical feasibility; and third, the aqueous homogeneous reactor has a strong potential for successful development as a thermal breeder with a doubling time of about 15 years, and therefore merits considerable under the objectives of extending the long doubling time of the liquid metal fuel reactor and molten salt reactors, these systems are the only marginal values of interest as thermal breeders.

Dr. PITTMAN. These are the two systems we are doing some work on in 1960, and plan to continue in 1961.

Mr. RABAUT. How long will it take to find out about this?

Dr. PITTMAN. I hate to predict how long it takes to get results from an experimental program. This program has been reduced from a $20 million program down to about a $5 or $6 million program now, sir.

Mr. RABAUT. I know, but even what is left is a valuable sum.

Dr. PITTMAN. Yes, it certainly is. $2 million of this for the continuous operation of the aqueous homogeneous experiment from which we are getting valuable information. The reactor ran for some 125 days without stopping. It showed the system is feasible to operate. The idea of having some system that we can use as a thermal breeder in our program I think is a well worthwhile objective.

Dr. WILSON. The long-range value of thorium must not be overlooked, even though it seems that it will not meet the earlier objectives. It is very important in the long range and we should not entirely forget about it and throw away half your potential fuel but you should not work on it intensively.

Mr. RABAUT. In this agency the figures are all relative, but when we compare them with other programs we review, it is a lot of money.

COOPERATIVE PROGRAM

The estimate for the cooperative program is $25 million. How many kilowatts capacity of commercial power from nuclear plants have been added to the American total service since this time last year?

Dr. PITTMAN. Since this time last year, I think the only reactor that has actually come into operation is the Dresden reactor, itself, which is now operating at 90,000 kilowatts, as Mr. McCone announced yesterday.

Mr. RABAUT. What response have you had to the invitation on plants authorized and financed last year and what unsolicited proposals have you received?

Dr. PITTMAN. Under the 1960 authorization we put out invitations for a small pressurized water reactor, roughly 20 megawatts, an invitation for a 50-megawatt boiling water prototype, both of those under second round conditions, and we put out an invitation for a 50 to 75 megawatt organic reactor. We have finished up the negotiations with the Puerto Rican Water Authority on the bonus reactor which is a boiling water reactor, and we have received an unsolicited proposal on the 50-megawatt high specific power boiling water reactor.

Now, in regard to the three invitations I mentioned at the beginning we have received proposals from five utility companies on the small pressurized water reactor, the proposals on the other two, that is, the organic and the 50-megawatt boiling water reactor are due in on May 2. We have not yet therefore received those two proposals.

Mr. RABAUT. Do these utilities people plan on tying this into their grid?

Dr. PITTMAN. Yes, sir, that is the basis of the invitation and that is the basis on which they are submitting proposals.

Mr. RABAUT. Dr. Pittman, are there sufficient development funds in this budget to fully implement all proposals authorized last year and contemplated for authorization this year?

Dr. PITTMAN. Yes, sir.

Mr. RABAUT. Is there too much in it?

Dr. PITTMAN. No, sir.

LITIGATION CONCERNING DETROIT EDISON FAST BREEDER PLANT

Mr. RABAUT. Has all litigation concerning the Detroit Edison fast breeder plant been cleared up?

Mr. FLOBERG. The answer to your question is "No." The present status of the litigation is that the Commission's decision granting a provisional construction permit has been appealed to the Circuit Court of Appeals for the District of Columbia Circuit. The case was argued in March, about the last week in March, and that has now been submitted to the court, and is awaiting decision.

It has been appealed to the circuit court of appeals and there will not be any talk of further appeal until the court has decided.

LATITUDE TO CONSTRUCT IN LIEU OF COOPERATIVE ARRANGEMENT

Mr. RABAUT. You are asking for some latitude in connection with the cooperative projects authorization for 1961 according to your statement on page 80 of the justifications. Please explain this matter.

Dr. PITTMAN. The latitude that we are asking for is in the 1961 appropriations. We are asking for authority to spend $25 million either for the construction of reactors themselves, and this was on the basis that maybe we would not get an adequate proposal under the third round for this organic reactor which is now out under invitation. In case it would still look technically feasible and economically feasible to build it, we would want to have authority and funds to build the reactor.

On the other hand, in the event we do get a satisfactory proposal under our present invitation we would like to have authority to transfer some of that $25 million into operating funds so that we can do research and development under cooperative programs for other types of reactors that are not now in the program.

Mr. RABAUT. What types would they be?

Dr. PITTMAN. At this time, sir, we do not anticipate that there will be any types of reactors that we would ask for invitations to build. Our 10-year program does not envisage that the developmental work will proceed far enough so that it will be worth while to ask for proposals on any type of reactor. However, in a fast-moving developmental program it is quite likely that additional technical information will be available during 1961 that would bring us to the point where we should be building prototype reactors under the cooperative program.

We also have in the 1961 appropriation an authorization we are asking for up to $15 million to take care of unsolicited proposals.

Mr. RABAUT. I see that here.

Dr. PITTMAN. The unsolicited proposal idea is based on the fact that there are other people, some of the private laboratories and industrial labs, for example, who are carrying out experimental programs which will, we hope, lead in their case to some ideas about construction of reactors on a private basis. We would like to be in a position to consider proposals that they would submit to us without our inviting them, and we would propose to have the money for research and development of those systems.

Mr. RABAUT. None of these funds is specifically earmarked for round 2 projects. Does this mean that you plan to limit all work to private utility projects?

Dr. PITTMAN. No, sir. I think the authorization and the funds that we are requesting will be for either round 2 or round 3. I don't think it was specified that that has to be for round 3. It is $25 million. The money that would be available to us, sir, would be available for either round 2 or round 3. At the time we make a decision to build a reactor—at that time we can make a decision whether it is round 2 or round 3 or we construct reactors ourselves.

Mr. RABAUT. If you have a decision favorable to round 2, you will have money for construction.

Dr. PITTMAN. Yes, sir.

Mr. RABAUT. Under round 2 can you have an unsolicited proposal?

Dr. PITTMAN. No, sir. The $25 million that is in the budget request is for construction money. That money can be used for construction under round 2. We construct the reactor under round 2. That $25 million is available. The $15 million for unsolicited proposals cannot be used for construction. It is only for research and development. The round 2 proposals all envision construction by the Commission of that reactor. None of the $15 million is available for construction.

Mr. RABAUT. Your $25 million, isn't that earmarked for specific purposes?

Dr. PITTMAN. The $25 million is for construction of reactors, either for construction of the organic reactor in the event we do not get a satisfactory proposal, under the invitation that is now out, and due back May 2, or construction of any other reactors that the Commission may determine are needed in the 1961 period, either under the second round or at our own sites.

Mr. RABAUT. Would you plan to use it for anything but an organic reactor?

Dr. PITTMAN. In the event we do not need this for an organic reactor, then the plans would depend entirely upon the rapidity of the research program we are carrying out.

Mr. RABAUT. What do you plan to do now?

Dr. PITTMAN. At this particular moment there are no reactors planned except the organic for this $25 million. If we don't have the $25 million, and we don't get a proposal on the organic, then we would not be able to build this.

In answer to your question, if we do get a proposal on the organic reactor, do we have any specific plans as to this sitting as to what the $25 million will be used for, I will have to say no, because our research and development does not indicate at this moment that we will be building one. We certainly need the $25 million in order to assure them we can build the organic reactor which we think is one that should be built.

Mr. RABAUT. Then the money is not available for an unsolicited proposal in round 2.

Dr. PITTMAN. There is a $15 million——

Mr. RABAUT. Is it available for construction?

Dr. PITTMAN. No, sir; there is no unsolicited proposal in round 2. Our authorization calls for the issuance of invitations under round 2.

EVALUATION OF CONCEPTS FOR EFFICIENCY AND ECONOMY

Mr. RILEY. Dr. Pittman, in your studies and evaluation of reactor types to date, what type do you consider the most efficient and economical?

Dr. PITTMAN. The type that is the most economical to date, as of this moment, is the water-cooled reactor system, the boiling water, and the pressurized water. That is the situation as of this particular moment.

Mr. RILEY. What about the efficiency of it?

Dr. PITTMAN. They do not have the potential efficiency, looking into the future, of the higher temperature reactors such as the liquid metal or gas cooled. Those reactors on the basis of our present knowledge look like they have greater potentials for the future than either the water reactors or organic reactors. On the other hand, people will be building water-cooled reactors in the relatively near future; and the engineering improvements that will be brought about by the people building them, and the fact that they are being built as more or less commercial units, are going to do much toward keeping those reactors competitive for a long time to come. It looks to us now as though the water-cooled systems, relatively low-temperature systems, are in the best and most advanced state of development today, and are the most competitive today. It looks to us in the long-range future—by this I am talking about 10, 12, 15 years in the future—that the high-temperature system, gas and liquid metal systems, because of the fact they are higher temperature and offer higher efficiencies of conversions of energy to electricity, might be much better systems for the future.

On the other hand, you can't wipe out the water systems for the long range.

Mr. RILEY. Thank you very much.

Dr. PITTMAN. I am glad to say I include the organic more or less with the water. It is a hydrogenous system.

Mr. RABAUT. Mr. Evins.

PROGRESS IN ATOMIC POWER DEVELOPMENT PROGRAM

Mr. EVINS. Mr. Chairman, I listened to the statement of Chairman McCone yesterday and I want to say that my observation is that the AEC, a great agency, has grown in personnel, it has grown in installations, and it is doing great work in many fields, and is capable of doing even greater work in other departments if it were imbued with a greater sense of urgency in certain particulars. I would not suggest to offer any criticisms or advice on the weapons program or the medical and biological programs. I think you have done great work there. I know that Dr. Pittman is a competent, capable and able man, and if the bridles were taken off, we could start to move ahead in the reactor development program with some urgency.

I do, however, have a personal feeling that after all these many years we are still experimenting with reactors, we are still toying around with the idea, and I was impressed with what the Chairman said yesterday about the stretchout and the slowdown and the delay in bringing atomic power on the line, so to speak, for the consumers of

this Nation. While I respect the Chairman and the very able staff and the members of the Commission, I would just want to put in one word to urge, if we could, that there be a little more sense of urgency in your atomic power development program, and not let the private power companies slow down the stretch out and have their way at every point and every particular, so that the consumers of the Nation will be further delayed, disappointingly delayed, over a number of years in this great science, and art to which we think they are entitled, and which I think could be brought to the public at a faster rate.

When our Chairman of the committee asked Chairman McCone about the advance being made, he replied with a statement on the advances that France is making. We are glad that France is making advances. We know that England is making advances. I must say I have the impression that in this particular field while we have a competent staff, we are not going forward with the sense of urgency that I think we should. I just want to make that observation.

Mr. RABAUT. Mr. Boland.

Mr. BOLAND. Mr. Pittman, how many reactor concepts have been under study by the AEC? This is all of the reactor concepts.

REACTOR CONCEPTS

Dr. PITTMAN. For the purpose of power reactors, we have generally lumped them into five major general categories. The water reactors we break down into three separate subcategories, pressurized water, boiling water, and nuclear superheat. The next general category is the organic cooled reactors. We generally list reactor concept by coolant, organic coolant, water coolant.

The third general category is the sodium or liquid metal cooled system. We have looked at the fast reactors and, secondly, the thermal sodium reactors which are graphite moderated, the type that is being built at Halam.

Then the gas cooled reactor is another category. These are the reactors similar to the one that Philadelphia Electric is building under the high temperature gas cooled program, and the one that we have in Oak Ridge. The last category is the thermal breeder category of the fluid fuel category. That is where the fuel itself is not in solid state, but in a liquid solution being circulated through the reactors. So that we have the water cooler, organic cooled, liquid metal cooled, gas cooled and fluid fuel. That is five basic categories.

All those categories have been under study for some time, the latest being added to our system being the gas-cooled reactors that came into our program in the last couple of years in a rather large way.

Mr. BOLAND. The Commission has not yet come to any conclusion on which is the most feasible, best adaptable, and the one that we ought to concentrate on?

Dr. PITTMAN. I think the problem there is that there probably is no one reactor that is the most feasible and the best adaptable and the most economical for all uses. The fact is that large central station units may require entirely different type of reactors than the small compact units that have to be highly portable.

Mr. BOLAND. Is this because of the power that would be generated by this specific reactor?

Dr. PITTMAN. No. I am thinking more about the characteristics of what you have to do with the reactor to get it to where it is going to be used. If you have to have a highly compact reactor, the design has to be one that has a high power density, a lot of power in a small space, so that the reactors you are using for propulsion, for instance, are not necessarily the same type that will be used for large central station powerplants where the compactness of the unit is not as important as in other places. Certainly reactors that are furnishing power in space are going to be entirely different types of reactors than those in submarines.

COMPARISON OF WATER-COOLED AND GAS-COOLED REACTORS

Mr. BOLAND. Would this be true between the comparison of the water-cooled reactors and gas-cooled reactors? As I recall, the Commission was rather late in getting into the gas-cooled reactor concept, primarily I suppose from some of the testimony that I have gleaned before Chairman McCone came to the Commission, because it did not think this was a very good concept. However, as of a few years ago we changed the thinking in this direction and it was decided then that it is a good reactor.

Dr. PITTMAN. It has great potential.

Mr. BOLAND. Why do we go ahead with a gas-cooled reactor concept if we are now proving that the water-cooled reactors are feasible and would be adequate for the job that is to be done with relation to the generating of electrical power?

Dr. PITTMAN. I think the answer to that, Mr. Boland, is that our knowledge of the water-cooled systems right now indicates that we can in the relatively near future be building water-cooled reactors of very large size that will be economical in certain areas of the country where fossil fuel is very expensive, like in California.

Mr. BOLAND. And in New England.

Dr. PITTMAN. That is right. Where the cost of fossil fuel is quite high. This does mean, though, that you have to have not only high-cost areas, but you have to have areas that can use very large reactors. The use of a 300 megawatt single unit is not feasible in some areas of the country that do have high cost fuel. The other thing is on the basis of studies we have made to date and trying to predict with a certain amount of accuracy what can come out of the developmental program, we find that the water reactors seem to have some limit in just how low they can go in cost. We hope we are pessimistic but nevertheless they do have some limit as far as we can tell on how low they can go in cost of power. This level which we can reasonably predict they will reach, in the range of 7 mills, is just not low enough for nuclear power to be competitive in large areas of the country. Therefore we have the second objective. The first objective is to be competitive with fossil fuel in the high cost areas by 1960 or earlier. The second objective is to be competitive over increasing areas of the country so that nuclear power can take its place as a useful source of energy for large areas of this country. It is for this reason we have to look to the high temperature system like the gas system and the sodium system.

ORGANIC COOLED REACTOR

Mr. BOLAND. With reference to the organic cooled reactor, I have been out at the site in Idaho and I have seen the operation of that reactor. I must confess my ignorance in this field but it appeared to me to be a very fine reactor concept. I understand that it is in the experimental stage. But it seemed to me as if this particular program was a stepchild of the Commission, that the facilities which were available for experimentation with respect to the organic cooled reactor left something to be desired. On the basis of information which had been obtained from the operation of the organic cooled reactor, it would seem that we should have moved ahead a little more rapidly in this field. Of course the person who ran the shop out there was a good salesman. He did not sell us a bill of goods but he certainly sold us the program and from his conversation it did appear to be a good one. I am glad we are moving ahead more rapidly in that.

This budget carries an item of about $7 million for this very purpose. I note from the justification that there is $1 million reserved for a new contractor. Who is the new contractor and why do you need a new contractor?

Dr. PITTMAN. As you know, we are building the EOCR, which is to be a much more sophisticated research tool than the OMRE that you saw.

Mr. BOLAND. Is Atomics International the operator?

Dr. PITTMAN. It has not been chosen.

Mr. BOLAND. Who is doing the experimentation out there now?

Dr. PITTMAN. Atomics International has been doing experimental work both at their plant in California and at the OMRE in Idaho. In addition to the operator for the new OECR, organic cooled experimental reactor, we feel there is enough potential to the organic system that we should bring in other people who are knowledgeable in the chemical field, in the field of handling petroleum products, because that is what this coolant is.

I would like to comment on another point you made that this seemed to be the stepchild. This is not right for this reason: the organic system can depend for its physics and engineering on work that has been done in the water systems. They are both moderated by hydrogenous material. They are both relatively low temperature systems. Much of the work which has been done in water systems applies to the organic. In addition, we are building the second small reactor at Piqua and we have invitations out for the 50- to 70-megawatt reactor. In addition to the $7 million you see here, there is an additional $7 million in this budget for that large 50- to 75-megawatt.

Mr. BOLAND. With reference to a couple of the items under research and development, under organic reactor, I notice there is $100,000 for Monsanto and $100,000 for Cal Research. Have we expended money in this direction before to determine what the best coolant is or are we now getting into the problem of asking companies who are developing this coolant for their advice and their consultation?

Dr. PITTMAN. We have spent money in the past in trying to determine whether the particular coolant used in OMRE, a terphenyl type coolant, is the best coolant to use or not. The problem is one

of balancing physical properties, decomposition rates, and costs. You try to get a coolant which has good thermal properties, is not decomposed as it goes through the reactor and is inexpensive. Organic material decomposes and recombines to form material of higher molecular weight, which has to be taken out periodically. The cost of replacement of that material taken out is about three-tenths to four-tenths of a mill per kilowatt-hour for a reactor cooled with a typical terphenyl material.

Mr. BOLAND. Has this been the experience so far with the OMRE out there?

Dr. PITTMAN. This extrapolation to a large degree is based on the experience at OMRE. You have seen the large drums of polymer that have to be disposed of. What we are trying to do is to find out whether it is more economical to develop an organic material that will decompose at a lower rate or whether it is more economical to find one that decomposes into something that has a useful application. We are trying to see in the chemical field what effect the radiation has on the organic material.

GAS-COOLED REACTOR

Mr. BOLAND. Now, this budget carries the justification for the operation of a gas-cooled reactor at Oak Ridge.

Dr. PITTMAN. Yes, sir.

Mr. BOLAND. Weren't you engaged in building one at Idaho?

Dr. PITTMAN. Yes, sir; under the Army program. There is a small gas-cooled reactor under the Army program which will lead to a package reactor in a truck. That one is built and is being run by the Aerojet General Corp.

Mr. BOLAND. Thank you very much.

PROGRESS IN ATTAINING CHEAP POWER

Mr. RABAUT. I notice the utilities are always very interested in this atomic energy program. They must feel that the day is going to come when cheap power will be feasible. Now, we talk about this on a basis of comparison between the cost of nuclear power and the cost of conventional power. When this was originally thought of the price was going to be down so low that it was really going to be something, a terrific attraction. We hear very little of that now. The one big idea that the Government still has in this program in my opinion is that we should have a sort of yardstick on this, knowing about what things will cost for the production of power. Are we losing sight of that entirely or are we still having that original goal in mind that the cost of this will be down compared to conventional power? How is this going to eventually come out, in your opinion?

Mr. MCCONE. Originally it was felt, I think erroneously, that atomic power would be practically without cost. I think that there was some hope that maybe power would be so cheap that it would hardly be necessary to have a meter in your home to meter it.

Mr. RABAUT. That is right. Measure up the size of the place and they would establish the rate.

Mr. MCCONE. This does not seem to be a reality at the present time. The first objective is to be able to produce power which is

competitive. We would hope that this would not be the end of the road. It is not the end of the road in our program. We hope that as technology develops and we improve our processes that power from nuclear sources will become less in cost and in great areas throughout the United States and other parts of the world nuclear power will be less expensive than power from conventional sources.

This matter of comparison between the cost of nuclear power and the cost of conventional power covers a wide range because, as you know, in some areas the cost of B.t.u.'s from coal mines that are adjacent or gasfields that are nearby are very much different from the cost of B.t.u.'s where coal and gas have to be transported a considerable distance. We feel that we first must overcome technical problems that stand in the way of economically produced nuclear power, bringing it down to the point of being competitive in high-cost areas and then be progressively reduced. So the objective has not been changed. There is a recognition that the difficulties were greater than first expected.

Mr. RABAUT. When we went to England, we noticed the gas reactors that they were building over there and really tying them into their grid. It gave us a big interest in the gas reactor. I understand that AEC is now developing gas reactors.

Mr. MCCONE. We are now developing the advanced gas reactor. We are doing no work on the gas reactors of the type you saw in England. The reason we are not doing it is that there is not a single one of those units that would be of interest to us in any place in the United States from the standpoint of producing competitive nuclear power.

Mr. RABAUT. England has a different situation as to the cost of the fuel. It is unique because their fuel cost is high. A substantial percentage of their conventional fuel must be imported, and in addition to being costly, it is a drain on their balances.

COMPETITION WITH FOREIGN REACTOR BUILDERS

I have one more question. Have you had any success in selling reactors during this past year?

Mr. MCCONE. Foreign reactors?

Mr. RABAUT. Yes.

Mr. MCCONE. Some success.

Mr. RABAUT. Are we having any competition?

Mr. MCCONE. Yes, there is some competition. There is competition from British firms and Canadian firms.

Mr. RABAUT. How successfully are we competing?

Mr. MCCONE. We are getting our share of the business. There are several reactors under contract in European countries by American contractors. However, for reasons that we discussed yesterday, the whole field has been narrowed down by the fact that conventional fuels have been in abundant supply in Europe and elsewhere during the last 2 or 3 years, and consequently there is not the very great interest in hurrying along with nuclear power that existed a couple of years ago.

Mr. RABAUT. Mr. Jensen.

Mr. JENSEN. Without a doubt, the reason for the idea that was widespread many years ago, after the atomic bomb was exploded over Hiroshima, that power from atomic energy would be so cheap it would hardly be worthwhile to have a meter on the wall. I believe this was due to the fact that the cost of the atomic bomb that was exploded over Hiroshima had never been properly evaluated. You know when we are at war we pay little attention to cost. The war must be won at all costs. So I imagine someone in Government, possibly the military, got the idea that here was a source of cheap power. I don't know what the exact power of that bomb was, but no doubt if they had taken the cost of that bomb, even compared with its terrific power, it would cost several hundred dollars a kilowatt of equivalent power.

How long has it been since we started experimenting with atomic energy reactors for peaceful power? How many years ago? When did we first start on that?

Mr. MCCONE. I think we started on its development in laboratories in 1948 or 1949. I think it was at that time that the work was first started on a nuclear plant for a submarine. With the amendment of the Atomic Energy Act of 1954, serious steps were taken in the development of central station plants for power purposes, central station nuclear powerplants. Prior to 1954 the law was such that technical information was so restricted it was almost impossible to do anything on a commercial scale in the field.

Mr. JENSEN. Also, when did the Atomic Energy Commission start experimenting with the atom for agricultural, biological, and other purposes, and medical? About what year?

Mr. MCCONE. The experimentation has gone on for almost 25 years.

Mr. JENSEN. When did the Atomic Energy Commission start working on it?

Mr. MCCONE. I do not know exactly, sir. I would imagine that soon after the Commission was formed in 1947 they turned their attention to the biological and medical field. Prior to that time, the work in that field was confined largely to studying the radiation effects on their own employees and people in the nearby environment of their plants.

Mr. JENSEN. It has not been more than 10 years ago when you really started these experiments for agriculture. It is not over 10 years ago surely that you really found out what you could do with the atom.

Mr. MCCONE. That is right. I think very little was done before that. If it was done, it was done on such a modest scale it was not significant.

Mr. JENSEN. When did Mr. Strauss take over as Chairman of the Atomic Energy Commission?

Mr. MCCONE. Soon after President Eisenhower took office in 1953. I think Admiral Strauss was appointed Chairman of the Commission the 1st of July 1953, and for several months prior to that time he acted as special assistant to the President on atomic affairs.

Mr. JENSEN. And it is since that time that we made great progress in the atomic energy field for peaceful purposes in all of its ramifications.

Mr. MCCONE. Yes. May I say that this chart is rather a measure of what has happened. It shows that in the fiscal year 1951 the ex-

penditure for research and development on the civilian power program was at the rate of $5 million a year. In fiscal year 1953, it was raised to $10 million a year. In fiscal year 1956, it came up to about $50 million a year. We are recommending in fiscal year 1961 $172,800,000. So in 10 years the expenditures for research and developing, including cooperative projects in the civilian power program, rose from $5 million to $172,800,000.

Mr. JENSEN. Yes, and before that time most all of the emphasis was put on how we can build a bomb for the purpose of killing people and yet I read in a magazine where the man that was Chairman before Mr. Strauss says that the Atomic Energy Commission has been a complete flop. Now, if the Atomic Energy Commission has been a complete flop, this committee certainly deserves a good talking to by the American people, every member of it. We should be run out of office. I resent having those insults piled on this committee that Mr. Lilienthal piled on us. I consider that an insult to every member of this committee, not only to the members of AEC. Just about all that man knew in the atomic energy field was how we can best kill people, and I think he is doing a great disservice to his country. I am going to leave it all on the record.

Of course there have been times that I have not been completely satisfied with the progress which has been made in the field of atomic reactors, for instance, but I certainly can understand the problem that you folks have to cope with.

Now, last year, as recorded on page 99 of the hearings, I requested certain details of information relative to the various reactor concepts under active consideration. Now I believe you have already been requested to submit a similar informative statement for the record at this hearing. If you have not, I make the request that you bring the information furnished last year up to date and expand on it fully.

(The information follows:)

DESCRIPTION AND STATUS OF ADVANCEMENT OF TECHNOLOGY OF VARIOUS NUCLEAR REACTOR SYSTEMS FOR POWERPLANT PURPOSES

There are nine basic types of nuclear reactor systems which are under active consideration at this time in the development of economic nuclear powerplant systems. A description of each of these reactor types follows. In addition, explanatory work is underway on a number of novel and advanced reactor concepts. These are described under section VII, New Concepts Program.

DESCRIPTION—REACTOR TYPE

A. Water cooled

Pressurized water.—Fission heat is removed from the reactor core by water pressurized at about 2,000 pounds per square inch to keep it from boiling. Steam is generated in a heat exchanger through which the pressurized water passes.

Boiling water.—Water boils in the reactor core forming saturated steam which flows directly to a turbine.

Nuclear superheat.—In this concept steam formed in a reactor can be reintroduced into the reactor where it undergoes additional heating. This concept can be employed integrally with boiling water reactors or separately with a PWR.

B. Organic cooled

Involves the use of organic fluids for cooling and possibly for moderating, reflecting, and shielding nuclear reactors. Heat is removed from the core by organic coolant at low or moderate pressure. Steam is generated in boiler or heat exchanger.

C. Sodium cooled

Sodium graphite.—Sodium takes high temperature heat from core to intermediate heat exchanger.

Fast breeder.—Heat from fission by fast neutrons is transferred by sodium coolant through intermediate cycle to boilers as in sodium graphite type. Neutrons escaping from core into blanket breed fissionable plutonium 239 from fertile uranium 238.

D. Gas cooled

High temperature heat from reactor is carried by a gas to a heat exchanger where steam is generated. The gas returns to the reactor in a closed cycle.

E. Heavy water

Heavy water (D_2O) serves as reflector and moderator, pressurized or unpressurized. Coolant may be pressurized, heavy water, light water, or other liquid. Heavy water makes possible the use of normal or slightly enriched fuel allowing for reductions in fuel cycle costs.

F. Fluid fuels

Uses solution or suspension of fuel in fluid carrier medium. The fuel solution or suspension is pumped into the reactor vessel where it generates heat and then through a heat exchanger where it gives up its heat to make steam.

STATUS OF DEVELOPMENT

I. Light water cooled reactors

There is a relatively high probability that light water cooled reactors in the reasonably near future can achieve competitive power in the high fuel cost areas of the United States where large single units are practical. In addition, water reactors also offer a longer range potential for being competitive in many other areas of the United States.

Over the next 4 or 5 years, Commission-supported research and development work on water reactors will be aimed primarily at solutions of the problems of nuclear superheat, increased fuel life, decreased fuel costs, simplified fabrication techniques, fuel management, simplified and less costly containment methods and cheaper materials and methods of construction.

A major effort will be made to develop techniques for economically utilizing plutonium as a fuel material in water reactors.

The water cooled reactor program is described under three categories: pressurized water, boiling water, and nuclear superheat.

A. Pressurized water reactors.—The pressurized water reactor concept is technologically well advanced and is the concept with which we have had the most experience. This experience has demonstrated that pressurized water reactors are safe, dependable, and reasonably easy to control. Capital costs of a 300 MWE plant of this type, as quoted recently by the manufacturers on a fixed price basis, when taken in conjunction with fuel guarantees reported to the Commission by utilities and core manufacturers, indicate that the power produced from such a plant constructed now should be competitive over its life in high fuel cost areas of the United States where a plant of this size can be used.

Plans for use of existing or authorized facilities: (*a*) The reactor at Shippingport, Pa., atomic power station will be modified to raise its power to 150 MWE equivalent. It will continue to be operated to demonstrate the life potential of the present rod-type blanket elements as well as of the newly developed high power density flat oxide seed and blanket elements. The present core will then be replaced by the newly developed 150 MWE high-power density flatplate oxide seed and blanket core. The reactor plant and its associated facilities will be used also to further demonstrate the technical and economic feasibility of the seed and blanket concept. The developmental cores to be installed at Shippingport upon completion of the PWR core 2 lifetime will depend on the results obtained in the development, testing, and operation of PWR core 2. For example, consideration will be given to: the installation of still higher power cores if feasible and/or the utilization of other fuel materials such as plutonium, uranimum 233, and thorium in this developmental reactor facility.

(*b*) The Yankee Atomic Electric Co. plant at Rowe, Mass., is scheduled for criticality in 1960. It will operate initially at 110 MWE. Among the important new features to be tested in the plant are stainless steel clad slightly enriched uranium dioxide fuel elements and solution poison for shutdown con-

trol. Statistically important utility operating and maintenance experience will be gained from this relatively large-scale reactor operating principally as a power producer.

(*c*) Two pressurized water reactors are being built by private industry without substantial Government assistance: A 151-MWE reactor is being built by the Consolidated Edison Co. of New York at its Indian Point, N.Y., plant which, with conventional superheat, will produce 255 MWE. It is scheduled to go critical in 1961. The Saxton Nuclear Experimental Corp., 5 MWE reactor experiment will furnish steam to the Pennsylvania Electric Co. plant at Liberty, Pa., and is scheduled to go critical in 1962. These plants will add much information to the technology of pressurized waterplants. The Indian Point plant will provide important operating data for large water-cooled reactor systems and technical data on the use of thorium U^{233} fuel mixtures.

(*d*) A 40-thermal megawatt process heat reactor is to be built in California in cooperation with the Department of Interior. It is scheduled to go critical in 1962. This reactor will explore the economics of reactors for production of low temperatures, low pressure steam for use by the process industries.

(*e*) A 16-MWE prototype with 6 MWE conventional superheat will be built primarily to demonstrate the economics of pressurized water reactors as small power reactors. This reactor will provide operating information important to the design of large pressurized water reactors. The feasibility of bulk boiling in pressurized water reactors will also be demonstrated in this reactor. Five proposals have been received for this reactor to be built under a second round type authority. The target date for criticality is 1962.

B. Boiling water reactor program.—The technical feasibility of boiling water reactors has been successfully demonstrated by the Borax experiments at the National Reactor Testing Station in Idaho, the Experimental Boiling Water Reactor at Argonne National Laboratory, and the Vallecitos Boiling Water Reactor in California. Based on currently available information there is every reason to believe that the large Dresden plant now in initial operation, the Humboldt Bay plant, and the Rural Cooperative Power Association Elk River plant all using boiling water reactors of varying size and design, will operate successfully and will furnish valuable information.

Plans for existing and authorized facilities—Domestic civilian power program: (*a*) The modifications now underway on the experimental boiling water reactor which will raise its power to 100 MWT, will be completed and the experimental program of study of the behavior of the boiling water system will be resumed. The modified reactor will be used initially to demonstrate the stability of a boiling water reactor at higher power density, and it will serve as boiling water fuel element test facility. Plutonium fuel development and water chemistry will be studied in this reactor.

(*b*) The 16 MWE indirect cycle boiling water with 6 MWE conventional superheat, Elk River plant is scheduled for criticality in 1960. This reactor is primarily of interest in the small powerplant program. Experience gained from it will also aid in the evaluation of certain variations in boiling water reactor design of possible interest to larger plants. These variations include use of mixed thorium oxide and uranium oxide fuels and of an intermediate heat exchanger in a boiling system.

(*c*) Three boiling water reactors have been built, or are being built, by private industry without substantial Government assistance. General Electric's 20 MWT (5 MWE) Vallecitos boiling water reactor near Pleasanton, Calif., is being modified. Commonwealth Edison Co.'s 180-MWE Dresden Nuclear Power Station at Morris, Ill., has gone critical, and the 48 MWE Humboldt Bay (Calif.) Reactor of the Pacific Gas & Electric Co. is scheduled to go critical in 1962. The experimental and operational data from these reactors will add much information on the technology of boiling water reactors and the latter two will provide valuable statistical operation and maintenance data for water-cooled reactor systems. The programs of these reactors will supplement the work being carried out in plants built with Government support, and will be an important part of this country's overall program for the development of boiling water reactors.

(*d*) Construction of a 50–75 MWE high-power density boiling water prototype is planned to begin in 1960 with criticality scheduled for 1963. This plant will be designed and operated in such a way as to provide technical and economic information on operation at power densities of the order of 60 kilowatts per liter and at fuel lifetimes similar to those experienced at lower densities. Nego-

tiations are currently underway between the Commission, the Consumers Power Co. of Michigan, and the General Electric Co. to develop a mutually satisfactory cooperative program for this reactor. Information from this program will be of value to both large and small power stations.

(*c*) A simplified 50 MWE boiling water prototype reactor will be constructed to demonstrate design improvements which will reduce the size, complexity, and cost of boiling water reactors. Such features as improved control methods, simplified containment, elimination of high risers, and increased power output per unit of waterflow will be incorporated in the design. Invitations have been issued for proposals from interested utilities. It is expected that construction will start in 1960 or early 1961. The target date for criticality is 1964. While this reactor will be primarily a prototype for future large reactors, the engineering improvements made will, in general, be equally applicable to small reactors.

C. Nuclear superheat.—Nuclear superheat can be applied to both direct and indirect cycle boiling water reactors, and to indirect cycle pressurized water reactors. In direct cycle boiling water reactors, nuclear superheat may be integral. In indirect cycle reactors, whether boiling or pressurized, what is essentially a separate steam cooled reactor would be required to obtain nuclear superheat.

Nuclear superheat would make possible production of steam at temperatures and pressures used in modern conventional powerplants of high efficiency. Development work and design studies have been underway for some time, concentrating chiefly on the superheat fuel element. Data from these programs are applicable to both direct and indirect cycle reactors. Design studies and evaluations have been made on integral superheat systems, and soon will be initiated on separate superheat systems.

Domestic civilian power program: (*a*) The fifth boiling reactor experiment (Borax 5) is under construction at the National Reactor Testing Station and is scheduled to become critical in March of 1961. The reactor will be operated initially with a limited number of test channels producing superheated steam and will be converted gradually into an integral nuclear superheat reactor. Flexibility designed into the system will permit investigations of nuclear stability problems associated with various fuel and coolant arrangements.

(*b*) The Northern States Power 62–MWE plant near Sioux Falls, S. Dak., is under construction and is scheduled for criticality in 1962. This reactor will provide test and operating data on a high density, integral nuclear superheat core. Development work leading to reduction in the enrichment of fuel in the superheat section of the core will continue.

(*c*) A contract has been signed with the Puerto Rico Water Resources Authority for construction of a 16-MWE boiling nuclear superheat reactor (Bonus). This reactor will provide information on the practicality of an integral nuclear superheat design for small reactors, and will assist in the evaluation of nuclear superheat in large plants. The target date for criticality is early 1963.

II. Organic cooled reactor program

There is relatively high probability that organic cooled reactors can achieve competitive power in high fuel cost areas of the United States by the middle 1960's and in the longer range over many other areas. Because of the success in operation of the organic-moderated reactor experiment and in other research and development work already done, because of the relative simplicity of the system, and because of the direct applicability of much of the technology developed in water reactor programs, it is believed that this concept can achieve its early potential with less research and development and construction of experimental and prototype plants than are required for reactor concepts.

Organic cooled reactors operate at higher temperatures and lower pressures than water reactors, and have no major corrosion problems. These characteristics make for low capital cost plants. However, high costs for replacing decomposed coolant are an economic disadvantage. Organic coolants also have poor heat transfer characteristics and require fuel elements with extended surfaces and high conductivity cladding. Since a longer lived fuel must be developed, research and development work at present is primarily on aluminum-aluminum oxide claddings for uranium oxide and uranium alloy fuel materials. Research and development work also is directed toward lower organic makeup costs and improving organic fluid flow and heat transfer characteristics.

In the longer range, the research and development program will be directed toward utilizing plutonium recycle in organic reactors.

Plans for use of existing or authorized facilities.—Domestic civilian power program: (*a*) The 5–15 MWT organic moderated reactor experiment (OMRE) at the National Reactor Testing Station is being modified to make it a more suitable test facility and to reduce its cost of operation. It will continue to be used as a fuel test facility, for determining coolant decomposition rates, and for conducting heat transfer and surface fouling tests.

(*b*) The 40 MWT experimental organic cooled reactor (EOCR) is presently being designed with construction scheduled to start this year at NRTS. It is scheduled to be critical in 1963. This facility will have more flexibility than the OMRE. It will allow an acceleration of the rate at which alternative fuels, coolants, moderators, and operating conditions can be investigated, and it will give greater assurance that improvements will be available for organic reactors that might be built in the future.

(*c*) The 11 MWE organic cooled and moderated reactor being built for the city of Piqua, Ohio, is scheduled for criticality in 1961. It is of primary importance as a prototype for small nuclear powerplants, and it will make possible a reasonable analysis of the potential of the organic concept in this size. It will also provide operation data that can be extrapolated to larger plants.

(*d*) A 50–100 MWE organic cooled prototype is planned for construction. Its primary purpose will be to provide data on use of an improved fuel such as aluminum cermet clad uranium dioxide. An invitation for proposals to build this reactor has been issued under the fiscal year 1960 authorization. Should no acceptable response be received to the invitation, and if research and development results continue to be favorable, the Commission proposes to start construction with funds included in the fiscal year 1961 appropriation request. The target date for criticality of this reactor is 1964. It is primarily a prototype for future large scale power reactors, but the basic fuel element information which it will develop will be important for process heat and small power reactor systems.

III. Sodium-cooled reactors

Sodium-cooled reactors appear to have a high potential for achieving competitive power in large areas of the United States in the late 1960's or early 1970's.

Sodium has many attractive features as a reactor coolant. It is liquid at relatively low temperatures, has a very high boiling point, reasonably low neutron absorption cross section and excellent heat transfer and heat transport qualities. These characteristics make possible very high steam cycle efficiencies. Because of the negligible pressure required for sodium systems very large sized (500 MWE and larger) reactors are practical. This is an advantage since unit power costs generally decline with increased plant size. The Experimental Breeder Reactor No. 1, the sodium reactor experiment and the submarine *Seawolf* and its prototype reactor have demonstrated that sodium-cooled reactors can be operated safely. However, there still are problems with fuel elements and components which must be solved before these systems can achieve their full potential.

Since liquid sodium is not in itself a moderator, systems which use this material as a coolant can operate over a wide neutron energy spectrum, depending upon the presence and characteristics of moderating material. In fast and possibly in epithermal systems, sodium-cooled reactors are capable of breeding. Sodium-cooled reactor systems can also operate with uranium 238-plutonium fuel systems or with thorium-uranium 233 systems.

The Commission's program for sodium-cooled reactors is presented below under two headings—fast reactors and thermal reactors.

A. Sodium-cooled fast reactors.—Most of the technical and economic advantages which are inherent in the use of sodium as a reactor coolant apply to fast systems. They have an additional advantage in their ability to achieve high conversion ratios or to breed.

The research and development program for fast or epithermal liquid metal-cooled reactor system is long range in nature and is expected to yield significant results in the late 1960's. In its initial stages, it will concentrate on the development of a satisfactory, long life, high burnup fuel material; on the utilization of plutonium and uranium 233 as fuels and of uranium and thorium as blanket materials; on the development of reliable and less expensive sodium components; and on the development of efficient and rapid fuel recycle methods.

Plans for use of existing or authorized facilities—Domestic civilian power program: (*a*) Operation of the first experimental breeder reactor (EBR–1)

at NRTS will be continued. Upon completion of the current safety experiments, a plutonium cermet core will be installed.

(*b*) The second experimental breeder reactor (EBR–II) at NRTS is scheduled for criticality in late 1960. The first core for this reactor will utilize U^{235} fuel. The subsequent core will be fueled with plutonium. This plant will incorporate onsite pyrometallurgical fuel processing.

(*c*) The 94-MWE Enrico Fermi plant at Monroe, Mich., is scheduled for criticality in 1960. Test information on the uranium 10 weight percent molybdenum fuel performance, on fuel rotation, on fuel processing, on core physics, and on overall plant performance will be important to the advancement of fast reactor technology.

B. Sodium-cooled thermal reactors.—Sodium-cooled thermal reactors have the potential of achieving economic power in high fuel cost areas of the United States. These reactors can be operated at high temperatures and low pressures. However, to obtain full benefit from these characteristics, a greatly improved fuel element must be developed: one capable of long life in the high-temperature environment. For this reason it is unlikely that this potential can be achieved at an early date.

Since sodium-cooled fast reactors offer most of the advantages of the sodium-cooled thermal systems and in addition, offer the possibility of lower fuel costs through breeding, work on sodium-cooled thermal reactors would not be expanded until operating results from the Hallam reactor, now under construction, can be evaluated. Research and development for sodium-cooled thermal systems will concentrate on uranium carbide fuel development and on major improvements in the design, efficiency, and performance of the sodium components. In carrying out this program, full consideration will be given to the points of similarity between thermal and fast-cooled systems and the work will be directed in such a way as to achieve maximum benefit to both.

Plans for the use of existing or authorized facilities—Domestic civilian power program: (*a*) The sodium reactor experiment (SRE) in California will be returned to operation. For the next several years, its use will be limited to testing of advanced fuels and other work in support of the Hallan plant. When this work is completed, and if the potential of the concept shows continued promise, the SRE will be reassessed as to its suitability for conversion to a high-temperature fuel test facility, or to an advanced experimental reactor to demonstrate improvements in thermal sodium-cooled systems.

(*b*) The Hallam (Nebraska) nuclear power facility is scheduled to reach criticality early in 1962. Operational plans for this 75-MWE plant include continued testing and evaluation of promising fuels, looking toward reduction in fuel cycle costs. Operating experience and tests with the plant are expected to yield valuable technical information regarding all sodium-cooled reactor plants, including those to operate with neutrons in the fast and intermediate energy spectrums.

IV. Enriched gas-cooled reactor program

Enriched gas-cooled reactors have the potential of producing superheated steam of the quality currently in use in large conventional central station powerplants with the resulting high efficiency. Gas-cooled reactors can operate at low pressure and therefore can be built in very large sizes.

The Commission has two approaches to the gas-cooled reactors program, exemplified by the 22.3-MWE experimental gas-cooled reactor (EGCR) now under construction and the Philadelphia Electric Co.'s 40 MWE (28.5 MWE with metal-clad fuel) high-temperature gas-cooled reactor (HTGR). The HTGR will employ a core utilizing a graphite-clad fuel consisting of fully enriched uranium carbide and thorium carbide dispersed in graphite . The EGCR is a reactor utilizing stainless steelclad, slightly enriched UO_2 fuel. In the case of both reactors, heat is removed from the fuel by the helium coolant and is transmitted to a heat exchanger where steam is formed to drive the turbine. The graphite-clad system shows greater economic potential than the metal-clad system, but presents more difficult development problems.

The present and immediately foreseeable research and development program its concerned primarily with the design and construction of the EGCR and HTGR. Their construction and operation will make possible a more comprehensive evaluation of the potential of the gas-cooled reactor system. The program also will include investigations of fuel and cladding materials suitable for high burnup at fuel surface temperatures of 1,700° F. and higher and of alternate coolants.

Plans for existing and committed facilities.—Domestic civilian power program: (*a*) The 22.3-MWE experimental gas-cooled reactor (EGCR) at Oak Ridge is scheduled for criticality in 1962. This power-producing prototype will furnish statistically significant economic data on operation of gas-cooled reactors. It will be used as a flexible test facility which will permit the testing of advanced fuels, materials, and components suitable for use in future gas-cooled power reactors. Work on this project will be carried out in close cooperation with work of the United Kingdom on its advanced gas reactor (AGR).

(*b*) The Philadelphia Electric Co.'s 28.5 MWE (initially 28.5 MWE) high-temperature gas-cooled reactor (HTGR) is being designed and is scheduled for criticality in 1963. The work supporting this project includes development of impervious graphite, uranium carbide-thorium carbide fuel dispersed in graphite, high-temperature components, and auxiliary systems including methods for trapping fission products which may get into the gas coolant.

V. Heavy water reactor program

Heavy water moderated natural uranium fueled reactors have a number of unique advantages. For example, they eliminate dependence upon diffusion plants in the fuel cycle, they have high neutron economy, and they require relatively small quantities of uranium ore per unit of power produced. On the other hand, these reactors are physically large with consequent high capital costs. The reactivity lifetime of the natural uranium fuel is more limited than that of enriched uranium fuel.

Several prototypes of natural uranium heavy water moderated reactors are planned or are under construction in the United States. Also, the Canadians are planning construction of both a 20-MWE prototype, the NPD, and a 200-MWE natural uranium heavy water moderated plant, the CANDU. These plants are scheduled for criticality in 1961 and 1965, respectively. Negotiations are currently underway with the Canadians looking toward an expanded program for cooperation in the development of heavy water reactors. Close cooperation under this agreement will be mutually beneficial and, in addition, will serve to assist the Commission and U.S. industry in determining the future role of heavy water reactors in this country.

The U.S. research and development program will be directed toward those problems which are critical to the evaluation of heavy water—moderated systems. To the fullest extent possible, it will use pertinent information being developed in other programs and in other countries. The critical problems are those associated with reactivity limitations on fuel lifetime (including fuel management techniques for extending these limits), minimizing loss of heavy water, and techniques for fabricating components of pressure tube or pressure tank systems. One difficult design objective is to obtain the high-coolant temperature needed for high thermal efficiency while maintaining the cool moderator necessary for long fuel-reactivity lifetime. The research and development program and cooperation with other countries will be planned so that the combined results will provide a sound basis for evaluation of this class of reactors, including designs which use coolants other than heavy water (e.g., organic and gas).

Plans for existing and authorized facilities.—Domestic civilian power program: (*a*) The heavy water components test reactor (HWCTR) is scheduled for criticality in 1961 at the Savannah River plant. This reactor will be used to obtain operating information on a heavy water-moderated system under conditions similar to those that might be suitable for power production. It will provide irradiation tests on fuel elements being considered for heavy water-moderated systems, and will provide tests of other components such as pumps, valves, and instrumentation.

(*b*) Research and development on a cooperative basis in support of the 50-MWE reactor of the East Central and Florida West Coast Nuclear Groups will continue, looking toward an early evaluation, in accordance as to whether or not the project will proceed with plant construction. If built, the reactor is scheduled for completion in 1963.

(*c*) A heavy water-moderated and cooled pressure tube reactor of 17 MWE capacity is being designed and is scheduled for criticality in 1962 in accordance with a contract between the Commission and the Carolinas-Virginia Nuclear Power Associates, Inc. This reactor will provide additional data on the performance of heavy water reactors.

(*d*) The plutonium recycle test reactor (PRTR) is scheduled for criticality in 1960. This is an experimental facility to investigate the economic feasibility of plutonium recycling. However, the fact that this reactor uses heavy water

as a coolant and moderator, incorporates a pressure tube design, and operates at power reactor temperatures, makes it an important source of additional information and technology.

VI. Aqueous homogeneous reactor program

The aqueous homogeneous reactor offers many advantages for production of power since it operates with a solution fuel, incorporates continuous fission product removal, and is largely self-regulating due to its large negative temperature coefficient. It further offers the possibility of breeding when operated on a thorium-uranium 233 fuel cycle. Major technical problems are associated with the corrosive nature of the fuel, stability of the fuel solution under irradiation, the maintenance problem associated with the radioactive primary loop, and the limited operating temperatures with the attendant low steam cycle efficiencies.

It is still too early to determine whether the simplicity of the fuel cycle and potential breeding will be more than offset by technical complexities and temperature limitations. Because of the unique advantages and the fact that this is the main effort on fluid fuels, research and development will be continued on the technical problems on a long-range basis.

Plans for use of existing facilities.—Domestic civilian reactor program: (*a*) Research and development work will concentrate on understanding and solving the fuel stability and corrosion problems in the core and on development of a suitable blanket material. Operation of the homogeneous reactor experiment nuclear (HRE–2) facility should be directed to aiding in the solution of the fuel stability, the remote maintenance, and other basic system problems.

VII. New concepts program

As technology is developing rapidly in many directions, the Commission must be alert to evaluate new reactor ideas as well as new ideas for major improvements in existing reactor types. However, a decision to proceed with the development of design alternates representing major technological advances depends upon an evaluation of the benefits expected to result. Such evaluation is difficult even when considerable technical data on each exists. Early construction of inexpensive reactor experiments may be justified to help determine the technical feasibility of advanced designs which look promising. The boiling reactor experiment (Borax), the organic moderated reactor experiment (OMRE), and the Los Alamos power reactor experiment (LAPRE) are examples of reactors built in minimum time at low cost to provide answers to specific questions as to technical feasibility.

The following reactor types or reactor modifications are typical of those currently being investigated. In several cases specific research and development is being carried out in areas critical to the evaluation:

(*a*) *Fused salt.*—This is a fluid fuel design based upon the use of a mixed salt solution of fissionable and fertile materials which is circulated from the reactor through an external heat exchanger. Potential advantages of this system are high thermal efficiency, low pressure, and simplified fuel reprocessing.

(*b*) *Fluidized bed.*—This design is based upon maintaining a bed of fissionable and fertile material in a fluidized state under turbulent flow conditions. Organic material or water are considered as possible fluidizers and coolants. High power density and ease of charging and discharging fuel are potential advantages of this system.

(*c*) *Paste or suspended fuel.*—This design is similar to the fluidized bed design except that the bed is maintained in a laminar, nonturbulent condition and is internally cooled by a separate coolant. Many of the potential advantages of the fluidized bed are retained. In addition, because of the nonturbulence, particle attrition is reduced and reactor control may prove to be easier.

(*d*) *Supercritical water cooled.*—A reactor based upon this concept would operate at extremely high pressure, avoiding the phase change associated with boiling yet permitting the generation of superheated steam external to the reactor. High thermal cycle efficiency is the potential advantage of this alternate.

(*e*) *Slurry.*—This design is based on a fluid fuel system in which the particle size of the fissionable or fertile material is so small that it forms a suspension under operating conditions. The reactor may be cooled externally or internally. The carrier fluids undergoing most active investigation are water and liquid metals. The potential advantages of this concept are similar to those cited for other fluid fuel reactors.

(*f*) *Advanced epithermal.*—A compromise design between sodium-cooled fast reactors and sodium-cooled thermal reactors may have advantages over either, particularly for the thorium fuel cycle. This design would include some moderation by graphite or beryllium, optimized for high conversion ratio with uranium 233 fuel consistent with economic promise. High thermal efficiency and low pressure characteristics of sodium-cooled system would be retained.

(*g*) *Pebble bed, gas cooled.*—In this concept a stationary bed of balls (or pebbles) containing the fissionable, fertile, and moderator materials is cooled by a gas. Potential advantages are in the area of low fuel cycle costs and high thermal efficiency.

(*h*) *Solid moderated, steam-cooled reactors.*—In this concept, heat from the fuel is radiated to the moderator (graphite beryllium oxide, zirconium hydride, etc.) which in turn is cooled by water or steam. High thermal efficiency is the principal potential advantage.

(*i*) *Alternate coolant fast reactors.*—This design is similar to the sodium-cooled fast reactor except that alternate coolants are being considered. These include mercury, lead, lithium, sulfur, and other materials. It is believed that with certain of the alternate coolants increased efficiency and reduced costs may be attainable.

Plans with respect to existing or authorized facilities—Domestic civilian power program:

(*a*) The Los Alamos molten plutonium reactor experiment (LAMPRE) is under construction. It will be operated to demonstrate the technical feasibility of a fast reactor using a fluid or molten fuel.

(*b*) The high-temperature gas-cooled reactor experiment (TURRET) under construction at Los Alamos would establish the feasibility of operation with a gas coolant at temperatures above 2,000° F. An attempt will be made to handle a very radioactive primary system. This reactor might have direct application in supplying process heat to the chemical and metallurgical industries.

Mr. JENSEN. Of course, the facts are that over the past number of years, the past 10 years, our conventional producing electric power system has reduced the cost of producing electric power, conventional power. We are in some areas producing power now from natural gas at a little over 3 mills per kilowatt-hour. Ten years ago you never heard of anybody producing power, conventional power, from a steamplant at less than 5 mills per kilowatt-hour.

Now the Pacific Gas & Electric Co. claim they are going to produce electric power from atomic energy for around 8 mills. I am not one that expected that we would be producing electric power from atomic energy at competitive prices with conventional power. I was sure we would not be doing it for many years, and maybe never. I am not sure that we will ever make atomic power competitive with natural gas power, or coal, or oil. The gasoline supply, the oil supply, and coal supply is going to run out someday, and we had better have something to take its place. If it were not for that fact, I would oppose every appropriation for the building and experimenting with these atomic powerplants.

Mr. EVINS. Will the gentleman yield?

Mr. JENSEN. Not now.

Now, we have cooperated, the Government has, with private industry. Private industry has spent a lot of money, and they knew they were going to have to spend a lot of money in order to live up to their part of this great activity. They are hiring a lot of people who are well schooled in the art of nuclear science, and they are paying some big prices to get those people, bigger prices than the Government can pay to hire such fellows. So we have that advantage when private industry takes hold of that, or anything else, in cooperation with the Government. We not only carry out the American way of doing

things, but all the people have the advantage of knowledge of the people who are employed by private industry. So there you are; you are criticized on the one hand, Mr. McCone, for being too cooperative with private industry, and then you are sometimes criticized for not being sufficiently cooperative with private industry in all your programs. I do not relish your position, but I think you are holding up pretty well.

I have sat here listening to a lot of questions that are being answered, and every year I learn a little more about this important program. I have felt that we possibly are spending too much money on some atomic reactors. Now I am going to ask you this question: Are you satisfied with the results that you have achieved to date on the water-cooled reactors or are you continuing to improve that concept.? Do you think you are at the end of the road so far as improving on that concept or do you think you can build plants so large that you will reduce the cost of your power? That is my question.

PROGRESS OF NUCLEAR POWER PROGRAM

Mr. McCone. Mr. Chairman, I would like to respond to Mr. Jensen's question. In doing so I would like to make some comment on our entire power program, with your permission.

Mr. Rabaut. You may proceed.

Mr. McCone. Particularly, in view of the fact that Mr. Evins left me with the impression that yesterday, in answer to a question concerning our power program, I must have given him and perhaps other members of the committee the feeling that I thought the French program was advancing maybe more progressively than ours. Nothing could be further from my thought.

In regard to Mr. Lilienthal's statement, we are at a loss to understand it. He had not been in touch with the Atomic Energy Commission, certainly, since I came into office 2 years ago. We do not find that he has been in the office of the Atomic Energy Commission for several years. Therefore, I do not know the source of his information which caused him to make a press release which was rather broadly reported in the press to the effect that the nuclear power program was a "flop"—I think that was the word used. The development of nuclear power, extracting from uranium the heat, the energy that is in it and transforming it into usable electric power at reasonable cost has been a more difficult task than was first expected. Because it is more difficult, it has taken a little longer to do. Some think that it is impossible to reach the ultimate goal of very cheap nuclear power; because that is impossible, I think it will take a little longer to accomplish, but I still think it will be accomplished.

PROGRESS IN WATER-COOLED REACTORS

With respect to the water programs of course we are not satisfied. We are not satisfied with anything. That is why we keep working at them all the time. That is why we are recommending to you that you appropriate for our use in research and development large sums of money for the further improvement of the water programs and all other programs. We think that the water programs offer the greatest immediate potential. They can be improved from their

present status and those improvements come from increased efficiency, larger burnup and lower final plant cost and largely the application of superheat.

We are working in all those fields very aggressively. Despite the prospects of the improvements which are in the immediate future, we feel, as Dr. Pitman has said, that there is an ultimate limitation to the water reactors and for that reason we are placing a very great emphasis on other types of reactors, of which the high-temperature gas-cooled reactor, and I contrast that to the low-temperature Calder Hall type reactor, which we feel has no potential—the high-temperature gas-cooled reactor and the sodium-cooled breeder reactors and other even more advanced types of reactors. So we have in mind the great strides can be made with the water-cooled reactors; it will perhaps be in other types of reactors that our ultimate goal will be achieved.

I feel that one of the ways in which the water-cooled reactors have proven to be attractive is by building larger and larger units. It was only a year or two ago that we were talking about units of 100,000 or 150,000 kilowatts. Now we are talking about units of 300,000 to 400,000 kilowatts. This leads to lower cost on a kilowatt-hour basis. It, however, limits the field of application because the areas even in the United States where large units of that kind can be fitted into a grid are somewhat limited. I think that there are only 12 or 14 conventional plants with 300,000 kilowatts or larger that are now planned for installation in the United States.

So you see going to larger units in order to achieve cheaper power we limit our market. For that reason we are working, as we are on the round 2 projects which Dr. Pittman spoke of, in trying to reduce the cost of plants and the consequent power produced from them in smaller units. If we achieve this, then nuclear power becomes more attractive for smaller communities and for areas that do not have this enormous consumption that is required to absorb a 300,000- or 400,000-kilowatt unit.

PROGRESS IN THE OVERALL PROGRAM

With respect to our overall program, I think we have a more aggressive and a better balanced program than other countries, because I think we are pursuing the types of plants which will prove most advantageous within our own economy, and also most advantageous in the foreign countries, and therefore will give us a chance to offer to other countries some means of relieving them of their power shortage.

I have gone into the program of other countries very carefully, as I said yesterday, and I am convinced that we know more about this business than anybody else, and I think we are carrying on an aggressive program. The money that we are asking for from your committee is a very large amount. It is in support of what we think is the right thing to do. If we had other projects in mind we would ask you for more money. We have not. Therefore, all I can do is urge that this committee act favorably on the appropriations that we have requested. If you do so, I think you will find a year from now that substantial progress will have been made, just as it has been made in the last 12 months.

Mr. JENSEN. Have you made further experiments with atomic-powered airplanes?

Mr. McCone. Yes; we are carrying on this project. I think it will be discussed in considerable detail during these hearings. We can go into it now.

Mr. Jensen. That is all right. I know of course the problem of weight which apparently has been the main reason for not going faster in the field.

Mr. Rabaut. We plan to discuss that program later.

Mr. Evins. I just want to say further, Mr. Chairman, that I had not read Mr. Lilienthal's statement, that I had not heard of Mr. Lilienthal's statement until it was mentioned here, and I certainly am not echoing what he has said. I do want to express my own personal view to emphasize, if possible, as one humble member, and to urge a little more sense of urgency in this field by the Commission. If there is any criticism that Mr. Lilienthal or anyone has leveled, I don't think it should be directed at the Appropriations Committee. I think that the Appropriations Committee has been most generous in trying to provide the necessary funds for this Commission. If there is any criticism it should not be directed at the committee of Congress; but perhaps there are some views along the lines of my own that we are not going as fast or as strong or that there is not as great an emphasis on the program as we might wish.

Mr. Chairman, I do not think we ought to tailor the progress of our Nation on a comparison with how far the other nations have advanced or how far they have gone. You have just said that you are convinced that we have more knowledge in this field than other nations have. I am glad we have. I congratulate you and our country that we do have. I think that we were far in advance of other nations several years ago. I think in the intervening years they have begun to catch up. I think we should be further advanced. We should not tailor our progress just to the measure of the progress they are making. I want further to express the hope that we do not wait until the coal and the conventional fields are exhausted before this great science and power comes into practical being.

Mr. Rabaut. Mr. Pillion.

Mr. Pillion. Perhaps I better address my remarks to Dr. Pittman here. Do I understand that water coolant is perhaps the most efficient one that we have now?

Dr. Pittman. The reactor systems using water as a coolant is as of today the most effective and the most advanced systems we have.

Mr. Pillion. Now, does the temperature of the water make any difference?

Dr. Pittman. These systems are either pressurized water where it is under pressure of 2,000 pounds per square inch. The way you control the temperature in water is to put more and more pressure on it. We get between 26 and 28 percent efficiencies in reactors using water systems. A good efficient superheat plant on the other hand gets up in the 30 to 35 percent efficiency in a conventional plant.

Mr. Pillion. Is the Dresden reactor the latest and largest reactor?

DRESDEN REACTOR

Dr. PITTMAN. The Dresden reactor is the reactor that was built by the Commonwealth Edison and a group of private utility companies. It went critical in December of last year and it got up yesterday to half of its total power load. Its total power is 180,000 kilowatts. It has gotten to half power as of yesterday. It is going through the usual period of startup and shakedown operations that every reactor must go through. It is the largest reactor on the line now.

Mr. PILLION. Its capacity is 180,000 kilowatts?

Dr. PITTMAN. Yes, sir.

Mr. PILLION. It has reached 90,000 so far?

Dr. PITTMAN. Yes, sir. It is planned to run it at that a week or two and then shut down to see what problems may have arisen during this initial phase of that operation.

(Discussion off the record.)

Mr. PILLION. How much money does this company pay to the AEC for the fuel and the work that the AEC put into this?

Dr. PITTMAN. The AEC put no work into this at all. The AEC furnishes the U^6F as fuel material. Uranium hexafluoride. It furnishes enough of that material so that the reactor owner can have his inventory, keep his reactor running, and he in turn has had it fabricated in this case by the General Electric Co. The material is released to Dresden at 4 percent of its value per year. The company pays for any material that is not returned to us.

Mr. PILLION. What was the value of this material? They pay 4 percent. What do you compute the value of that to be?

Dr. PITTMAN. I will have to furnish that for the record. I do not have it with me at this time.

(The information follows:)

The current value of UF_6 is $9,403,716.

Mr. PILLION. How do you arrive at the value of that material for which they are paying a use charge at the rate of 4 percent?

Dr. PITTMAN. The value of it is the value that is in our published pricelist for the material. We publish a pricelist for this material. That is the basis on which they are charged the use charge of 4 percent for all the material they have used. That is the basis on which they pay us for the material which is burned up in the course of operation of the reactor.

COMPARISON WITH STEAMPLANT

Mr. PILLION. Now, a comparable steamplant installation costs roughly $200 per kilowatt?

Dr. PITTMAN. No; I think a comparable steamplant installation is less than $200 per kilowatt. I would say, depending on where they are located, it would be in the range of $135 to $150 a kilowatt.

Mr. PILLION. Then a comparable steamplant at $150 would cost in the neighborhood of $27 million for that size. Would that be about right?

Dr. PITTMAN. Yes.

Mr. PILLION. The cost of this plant without the fuel is more than double what an ordinary steamplant would be.

Dr. PITTMAN. That is about right.

Mr. PILLION. Now, the 4 percent they would pay the AEC for the use of this material, how would that compare with cost of coal?

Dr. PITTMAN. When a utility company buys its coal, it buys it, and it has to pay interest on the money that it has tied up in its inventory. I would say that is generally twice as high as 4 percent.

Mr. PILLION. How about the number of employees? Would there be more employees?

Dr. PITTMAN. The operating cost of a nuclear plant, including the operation—of course we have to get a lot more experience on it, we are estimating it is about twice as high initially as the operation and maintenance cost of a conventional plant. These are estimates, of course.

Mr. PILLION. How much of your total raw material, the $700 million per year, would you say could be applied to nonmilitary purposes, that you are buying or using for stockpiling for civilian reactor power producing purposes? How much of that would be allocated for that purpose?

General LUEDECKE. You mean how much do we estimate we will need as the years progress?

Mr. PILLION. That is right.

General LUEDECKE. I do not have those figures here. We have estimated an annually increasing amount. We will supply those for the record. They have to be based on how much power is going to be built.

Mr. PILLION. If we have a total kilowatt capacity of around 900,000 kilowatts in this country, even $200, that would be a total investment cost on a comparable steam plant, at a very, very liberal figure, of $180 million. That is peanuts compared to what we are spending per year on this whole program. So when we are talking about the urgency of this program, I am wondering about it because the cost is fantastic.

Dr. WILSON. A very small portion of our uranium 235 is going into reactors. Most of it is going into weapons.

Mr. PILLION. If you were to take into consideration all your employees, all your investments, all your research, everything that goes into your cost, how would those actual costs compare with the published price for enriched uranium?

PUBLISHED PRICE OF URANIUM

Mr. FLOBERG. Mr. Pillion, the published price for enriched uranium is meant to be a realistic price based on all the attributable costs to the isotope separation process that uranium goes through. Now, it is hard to do the accounting on this in some respects but nevertheless we do have the initial cost of the raw material that goes into the isotope separation process. On top of that we have to add the cost of the separation process, itself. Now we can do a pretty good job, though, of allocating these costs and we think that the published price as now

posted by the Commission is one on which the Government is certainly not losing any money and yet it is a fair one to reflect the actual cost of separating the isotopes and furnishing enriched uranium.

Mr. PILLION. Of course, many of the decisions have to be arbitrary and are not the type of decisions that a private corporation would make because you have investments here and it all depends on how you pay them off.

Mr. FLOBERG. That is right. Accounting decisions are arbitrary both in private industry and in Government. We do think, however, that the costs properly attributable to the isotope separation process have been fully allowed and fully taken account of in the posted prices that we have. Now, there has been talk from time to time about reducing the cost of enriched uranium. We have not come to any conclusion that we should reduce the price of enriched uranium. It seems pretty clear to the Commission that the price should be no higher than it is. I should think if there is any trend in any direction it should be a downward direction, but there is no contemplation on the Commission's part of reducing the cost at the moment.

Mr. PILLION. What interest rate do you have in your figures?

Mr. FLOBERG. On the Government's invested capital?

Mr. PILLION. That is right.

Mr. FLOBERG. This is not calculated into the cost at all, Mr. Pillion.

Mr. BURROWS. Yes, sir, it is. It is 4 percent. We also calculate depreciation.

Mr. FLOBERG. Four percent on all of the invested capital?

Mr. BURROWS. On all the invested capital; yes, sir.

Mr. PILLION. Are you representing that there is a full allocation of capital investment upon which interest is calculated?

Mr. BURROWS. Interest on all the investment which is devoted to this process is charged in, and can be accounted for under the price; yes, sir.

Mr. PILLION. That sounds pretty good to me, and I am sure to the members of the committee also.

Thank you, Mr. Chairman.

Mr. Chairman, may I have just one more minute? I have some staff questions. I will leave these for the record.

Mr. RABAUT. Put those in the record and supply the answers.

(The questions referred to follow:)

Question. What is the relative contribution dollarwise and percentagewise by the private utilities to the various cooperative projects as compared to that of the public agencies?

Answer. The chart below gives the dollar and percent distribution of AEC and the participating groups.

	Amount (in millions)	Percent of total
Total for publicly or cooperatively owned facilities:		
Research and development	$22.4	100.0
Plant, equipment, land, and fuel	77.6	100.0
Total	100.0	100.0
AEC contribution:		
Research and development	22.4	100.0
Plant, equipment, land, and fuel	48.7	62.6
Total	71.1	71.1
Contribution by publicly or cooperatively owned facilities:		
Research and development	0	0
Plant, equipment, land, and fuel	28.9	37.4
Total	28.9	28.9
Total for privately owned facilities:		
Research and development	88.5	100.0
Plant, equipment, land, and fuel	209.9	100.0
Total	298.4	100.0
AEC contribution:		
Research and development	48.2	54.5
Plant, equipment, land, and fuel	0	0
Total	48.2	16.4
Contribution by private organizations:		
Research and development	40.3	45.5
Plant, equipment, land, and fuel	209.9	100.0
Total	250.2	83.6

Question. Why are the public bodies given preferential treatment as compared with private utilities?

Answer. Since early 1955, the Commission has made use of its power demonstration reactor program to enlist the participation of electric utility organizations in the design, development, construction, and operation of nuclear powerplants to demonstrate their potential for the production of economic power. Within the framework of the Atomic Energy Act of 1954, as amended, the Commission has offered certain forms of assistance as incentive for utility participation. These offers have been announced in a series of public invitations for proposals from both private and publicly owned utilities. It is apparent that when Commission assistance is extended only to cover research and development work, the consumer-owned and cooperatively owned utilities are, in general, unable to participate because of charter and financial limitations. Therefore, the Commission, in recognition of the strong interest and desire of the publicly owned bodies to take part in the program, offers assistance to include payment for and ownership of the reactor. Cooperative arrangements have been liberalized by the provisions of Public Law 85–162, which includes authorization for the AEC to pay reactor operating costs and receive payment for steam delivered. Principally because of the preference provisions of section 44 of the Atomic Energy Act which in part states, "In the contracting for the disposal of such energy, the Commission shall give preference and priority to public bodies and cooperatives * * *" no private utility has responded to these invitations which incorporate the latter provision.

Question. Will you supply for the record the latest estimates of the power cost per kilowatt-hour for each of the nuclear power reactors now in operation

or under construction in the United States, giving detailed derivation of costs such as—

Capital investment per kilowatt of electrical capacity.
Interest rate.
Operation and maintenance cost.
Fuel cost and basis thereof.
Amortization of capital cost.
Assumed load factor of operation.

Answer. Listed on the attached sheet are the readily available nuclear power costs for projects in operation or under construction. As a matter of expediency, we have consolidated only these data which are readily available. These are examples of the unit cost information for reactor power projects.

Estimated energy costs for nuclear power reactors in operation or under construction

	Piqua	Yankee	Elk River	Humboldt Bay	Northern States [1]	Dresden	Hallam	PRDC	Consolidated Edison	Saxton	Shippingport
Investment per kilowatt of electrical capacity.	$790	$370	$425	$420	$344	Not available.	$555	$387	$327	Not available.	$1,253.
Fixed charges:											
Rate	14 percent	14 percent	8 percent	13.1 percent.	14 percent		11.1 percent.	14 percent	13 percent		14 percent.
Mills per kilowatt-hour	16	7.40	8.69	7.85	7.3			7.72	6.5		25.
Operation and maintenance cost	2	2	1.9	0.43	1.97		1	1.15	0.9		8.
Fuel cost	7.00	4.9	1.1 (fossil); 4.2.	2.43	8.66		7.02	5.91	5.8		18.
Assumed load factor	80 percent	80 percent	60 percent	80 percent	80 percent		80 percent	80 percent	80 percent		80 percent.
Net energy costs (mills per kilowatt-hour)	25	14.3	15.9	10.71	17.93		19.12	14.78	13.2		51.
Fuel costs basis:											
Uranium use charge	4 percent	4 percent	4 percent	4 percent	4 percent		4 percent	4 percent	4 percent		4 percent.
Plutonium credit	$12/gm	$12/gm	$12/gm [2]	$12/gm	$12/gm		$12/gm	$12/gm			$12/gm.
Fuel fabrication	$55/kg U	$200/kg U		$135/kg U	$158/kg U		$50/kg U	$5,700/kgo. U (core); 2,200/kg U (blanket).			
Fuel exposure	3,000 mwd/mt.	7,830 mwd/mt.	12,000 mwd/mt.	16,500 mwd/mt.	7,000 mwd/mt.		3,000 mwd/mt.	2 percent burn up	18,000 mwd/mt.		5,800 EFPH to 20,000.

[1] These estimates are being revised based on changes in fuel element design.

[2] U^{233} credit.

Question. Will you supply for the record the estimates of the power cost per kilowatt-hour for projects included in your 10-year civilian power program?

Answer. In response to the question, the following data is submitted. The first table identifies the prototypes and large-scale plants which are included in the AEC 10-year program report.

Analysis of cost of proposed AEC civilian power program, fiscal year 1961–69

[Cost in millions of dollars]

Reactor concepts	Proposed prototype construction [1]		Large-scale plants [1]	
	Size (MWE)	Cost	Possible date for determination of economical construction	Estimated cost (300 MWE)
Pressurized water	20–30 50–100 100	$70	1962	$65
Boiling water	50–100 20–30	45	1963–64	65
Nuclear superheat	100	30	1968–69	58
Organic cooled	50–100	30	1965–66	60
Sodium cooled:				
Fast	100	30	Late 1960's	70
Thermal	100	30		
Gas cooled	100	30	Early 1970's	65
Heavy water	None		Late 1960's	100
Aqueous homogeneous	50	20		
New concepts	(3)50	80		
Total	14	365		483

[1] The prototypes listed are part of the AEC 10-year program plans. Depending on technical consideration, certain of these may or may not be built. The large-scale plants are those which are assumed to be wholly financed by private industry or projects in which the AEC may participate in the development of these plants. The exact amount and type of assistance at this time has not been determined. The prototypes, because of their very nature, cannot be compared on a mills-per-kilowatt-hour basis. It is estimated that construction costs may approximate $350 to $400 per MWE. Operating costs for these same prototypes would also vary depending upon size and when they are placed in operation and type of operating plan carried out. For the large-scale plants (300 MWE), unit costs were developed as part of the 10-year program

The following table identifies the costs in mills per kilowatt-hours by concept and elements of costs.

[Cost, mills per kilowatt-hour]

Reactor type	Fixed charges	Fuel cycle cost	Operation and maintenance	Nuclear insurance	Total
Pressurized water	4.40	2.56	0.59	0.25	7.80
Boiling water	4.31	2.29	.61	.24	7.45
Light water moderated superheat	3.91	1.96	.61	.23	6.71
Organic cooled	3.53	1.83	1.09	.22	6.67
Sodium graphite	4.47	2.00	.65	.25	7.42
Gas cooled (enriched fuel)	4.63	2.62	.49	.24	7.98
Fast breeder	4.43	1.99	.79	.25	7.46
Aqueous homogeneous	6.38	2.12	2.53	.30	11.33
Heavy water	5.80	1.21	.91	.28	8.20
Coal-fired plants:					
35 cents per 10^6 B.t.u. fuel cost					
25 cents per 10^6 B.t.u. fuel cost					

NOTE.—All plants are based on 300 MWE size: 80 percent capacity factor; 14 percent fixed charges. The power costs are based on the equilibrium fuel cycle which will be 3 to 4 years after completion of construction.

The following table indentifies the basis of the fuel cycle charges.

Concept	Fuel cycle costs (mills per kilowatt-hour)	Dollars per kilogram of fabricated cost	MWD/MT average burnup
Pressurized water	2.56	UO_2–SS, $70	20,000
Boiling water:			
With superheat	1.96	UO_2–Zr, $90	19,000
Without superheat	2.29	UO_2–Zr, $90	19,000
Organic cooled	1.83	UO_2–APM, $75	19,000
Sodium graphite	2.00	UC–SS, $70	19,000
Gas cooled	2.62	UO_2–SS, $68.50	18,000
Fast breeder	1.99	PUO_2–U–15 without Mo, $385.	(1)
Thermal breeder			
Aqueous homogeneous	2.12	UO_2SO_4 in D_2O	(1)
Natural U–D_2O	1.21	U–ZR, $15	7,000

[1] 18 year doubling time.

PLUTONIUM PRICES

Mr. RABAUT. I would like to read from our field report when our committee visited the plant at Monroe, Mich.:

The Detroit Edison plant will produce substantial amounts of plutonium to be purchased by the AEC. Income from this source is included in the financial picture of the PRDC and the PRDC is seriously concerned about any reductions in the amount AEC will pay for plutonium. Such reductions below the current amount would reflect unfavorably on the economics of this venture and impose a financial hardship. AEC has always reserved the right to alter such prices.

This is information we gathered when we were out there. Please discuss the problem of plutonium prices in general.

Mr. FLOBERG. The commission in 1957, I believe it was, it was before I was on the commission in any event, did establish a price for plutonium, and the termination date on that price is June 30, 1963. We have within our legal authority to extend that date, but we have never done so and there is no contemplation at the moment of doing it.

Mr. RABAUT. 1963?

Mr. FLOBERG. Yes, sir.

1963 was a relevant date to the plant you are discussing because it will probably go into operation about the beginning of 1961, plus or minus a little bit. So the time during which it will be operating under the presently posted price, under which the Government is obligated to accept its plutonium, will be a short term period. The PRDC on the other hand has been on notice that this is the termination date on the present posted price of the plutonium, and I think that it was Mr. Vance who testified in 1957 that anybody who was building a plant based on a purchase price of plutonium higher than $12 a gram was to use his words "building his house on sand." I believe that is the exact quotation. So I think that the attitude of the commission on the subject has been on the record for 2 or 3 years. Now, it is perfectly true that a reduction in the price of plutonium will affect the economics of the PRDC plant. These are grown men, over 21 years old, and they must have realized this for a long time, and I would be concerned, too.

Mr. RABAUT. Their program has been somewhat retarded, too. They expected to go into operation before this time, did they not?

Mr. FLOBERG. They have had some technical difficulties, yes, sir, and it has slowed the plant down but not materially I think only a period of months.

Dr. PITTMAN. About 6 months beyond their original estimates.

Mr. RABAUT. Mr. Floberg.

Mr. FLOBERG. It is a good performance considering the relative status of this art and the technical complexity of the plant they are constructing.

EURATOM PROGRAM

Mr. RABAUT. Now we are going to take up Euratom program. You are requesting $2 million. How much of the $5 million appropriated for this program last year has actually been costed so far this year?

Mr. FLOBERG. It depends on what you mean by costed. If you mean actually expended, about $320,000. If you mean on the other hand obligated, the amount is around $700,000.

Mr. RABAUT. You won't need any more money, then. You have over $4 million unobligated.

Mr. FLOBERG. The money we are talking about is money to incur further obligations.

Mr. RABAUT. There is only one plant in prospect.

Mr. FLOBERG. Yes, but this is money for a research and development program that is being conducted jointly with Euratom. By joint, I don't mean the funds are pooled. I mean that the projects are run through a joint board which approves the technical merit of the projects in question and assures that they are not duplicatory of any work being done either in Europe or in the United States.

Mr. RABAUT. You planned on five or six projects last year. You only got into one, did you not?

Mr. FLOBERG. That is correct.

Mr. RABAUT. You were talking about five or six projects and you only got into one. You have only obligated $700,000 and you still feel you will need more funds in 1961?

Mr. FLOBERG. Yes, sir. Those projects were actually producing reactor projects. Those are funded by the European utilities in question. This is another part of the Euratom program. It is called the joint research and development program.

Mr. RABAUT. We are backing this program, aren't we, with this money?

Mr. FLOBERG. This is only the research and development program that this money goes into. It does not go into the power reactors themselves.

Mr. RABAUT. Your original budget estimate was $5 million.

Mr. FLOBERG. That is correct.

Mr. RABAUT. You reduced it yourself to $2 million.

Mr. FLOBERG. Yes.

Mr. RABAUT. You have only obligated $700,000, this year.

Mr. FLOBERG. So far. The reason we reduced it is because we felt the $3 million could be spent to better advantage in other programs because of the rate of these projects. I might say that the joint board in Brussels now has in its hands some $9 million of projects that are competing for this money. That is $9 million worth of U.S. projects for moneys to be spent in the United States. At the same time there

are about $40 million worth of projects that the Euratom side of this program has submitted on projects to be funded by Euratom with the money spent in Europe, principally in the Euratom countries. So we are talking here about the amount of money that we think this $9 million of projects that the joint board has in its hands now will prove to be of technical merit and will prove to be submitted by competent people and will prove to be not duplicatory of work being done elsewhere.

Mr. RABAUT. And calls for how much money from this fund?

Mr. FLOBERG. This is a $2 million item that you have here. We have $9 million worth of projects which will be competing for this money.

Mr. RABAUT. Now, last year you said:

> Of these amounts it is estimated that $5 million will be costed in fiscal year 1960.

Mr. FLOBERG. We sure overshot on that approach.

Mr. RABAUT. That is what I am getting at. So you cut that down to $2 million.

Mr. FLOBERG. I think we have distilled this a lot better than we did last year; yes, sir.

Mr. RABAUT. You see, you have a request here for $2 million, and you still have a balance of over $4 million out of the $5 million available this year.

Mr. FLOBERG. That is right. We have now tied it down to projects that have already——

Mr. RABAUT. You have only committed $700,000.

Mr. FLOBERG. That is correct. This program is just getting started, though.

Mr. RABAUT. Instead of having $5 million as you had last year, you have $6,300,000. So you have gone up the ladder. You asked for $5 million and committed $700,000 so it seems to me that funds for this program are growing. You don't need $2 million.

Mr. FLOBERG. The program is going slowly if that is what you mean. That is true.

Mr. RABAUT. It is going slowly, but the money is going up.

Mr. FLOBERG. That is right. It is a much lower rate than we anticipated.

Mr. RABAUT. I don't blame you for your anticipation but I blame you for activity. You are only using $700,000.

Mr. FLOBERG. Now, we have tied these figures to projects which have been scrutinized.

Mr. RABAUT. Do you have a list covering the $5 million this year? You have a balance of $4.3 million. You are asking for $2 million.

Mr. FLOBERG. That is right. When we originally drafted the budget we had 5 instead of 2.

Mr. JENSEN. Mr. Chairman, I think right at this point would be a good place for the record to explain Euratom. You don't have to do it now, but put it in the record, the countries involved and so on.

Mr. FLOBERG. I will be glad to do that. We confidently expect to have about $2½ of that $5 million obligated before the end of the fiscal year.

Mr. RABAUT. What do you plan to obligate it on?

Mr. FLOBERG. On meritorious projects that will be cleared.

Mr. RABAUT. Put them in the record and also a statement on Euratom.

(The information follows:)

Research and development projects authorized in United States under United States-Euratom joint program

Name of firm	Description of project	Amount
U.S. FIRMS		
1. Advanced Technology Laboratories, Division of American Standard.	Cold extrusion of zircaloy	$78,300
2. Do.	Fabrication of plate type fuel elements by ceramic spraying.	[1] 250,000
3. Armour Research Foundation	Improving zirconium alloys	40,000
4. Babcock & Wilcox	U^{238} resonance integral experiment	106,000
5. Battelle Memorial Institute	Boiling heat transfer and void distribution studies with water coolants.	[1] 59,000
6. Do.	Uranium mononitride as an improved fuel	125,000
7. General Electric	High performance of UO_2 program	[b] 687,000
8. North Carolina State College	Phase relationship in U–C–O system	[1] 20,189
9. Nuclear Development Corporation of America.	Wet steam as a reactor coolant (joint United States-Euratom proposal).	[1] 394,100
10. Radiation Application, Inc.	Diffusion of fission gases through uranium oxide and fuel element cladding.	38,000
Total		1,797,589

[1] Contracts awarded.

NOTE 1.—All contracts authorized are for one year, except as follows: [b] If contract runs for 2½ years $1,900,000 may be spent.

NOTE 2.—Additional projects, which by the end of fiscal year 1960 could increase the total amount obligated for research and development in the United States by about $825,000 (for an approximate total of $2.6 million), are not here included because the projects, although selected, have not formally been authorized by the Joint Research and Development Board in Brussels.

DESCRIPTION OF THE EUROPEAN ATOMIC ENERGY COMMUNITY (EURATOM) AND ITS COOPERATION WITH THE UNITED STATES

The European Atomic Energy Community (Euratom) was officially established on January 1, 1958, when a treaty, signed by the six member nations in March of the previous year, formally came into effect. The member countries are Belgium, France, the Federal Republic of Germany, Italy, Luxembourg, and the Netherlands. The Euratom Community is one of three institutions comprising the European Community, the other two being the Economic and the Coal and Steel Communities. The primary responsibility of Euratom is to encourage and develop the peaceful uses of atomic energy within the member states, including the speedy establishment and growth of nuclear industries, and attainment of the means for large-scale production of nuclear power in Europe. Institutions of the Community that have been created to accomplish these purposes are (1) the Euratom Commission, the executive branch consisting of five members; (2) the Council of Ministers, a policy group representing the governments of the member states; (3) the Parliamentary Assembly, legislative representatives of the member states; and (4) the Court of Justice, which exercises judicial control over the Community. The last two organizations are common to all three of the communities.

An agreement for cooperation between the United States and Euratom came into effect on February 18, 1959, which provides for cooperation in a joint nuclear power reactor program with the primary objective of installing 1 million nuclear kilowatts in the Community by 1965. Under this program, reactor types are to be used that have been carried to an advanced stage of development in the United States. There was also established, as part of the agreement, a closely related joint research and development program for the purpose of improving the performance of reactor types to be constructed under the program, and lowering fuel cycle costs of such reactor types.

Reactor program.—In response to an April 1959 invitation for proposals to construct power reactors under the joint program, one definitive proposal from the Italian utility, Societa Elettronuclare Nazional (SENN) was received by the deadline date of October 20, 1959. The proposal provides for construc-

tion of a 150 mwe. boiling-water reactor at Punta Fiume, Italy. The prime U.S. contractor is the International General Electric Co.

Although other expressions of interest to participate in the joint program were received by the October 20 date, these expressions were not definitive enough at the time to warrant eligibility for the phase of the reactor program which has a target date of December 31, 1963, for initial reactor operation. Under the Euratom Cooperation Act of 1958, however, Congress has provided that completion of construction of two reactors may be deferred until December 31, 1965, and it is planned that an invitation for proposals for reactors to be in operation by this date will be issued by mid-1960.

Research and development program.—As stated previously, the agreement for cooperation with Euratom established a joint research and development program to be conducted in the United States and in Europe on the types of reactors to be constructed under the joint program. For the first 5 years, it was intended that each side would contribute up to $50 million for such research and development work. However, since these amounts were based on receiving proposals for more reactor projects than can at present be expected to participate in the joint program, it is doubtful that actual expenditures will be in this order of magnitude.

Interest in the research and development program, as gaged by the number of proposals that have been received for work in the United States and Europe, has been impressive. Some 286 proposals were received from U.S. and Euratom sources by April 1, 1960, in response to an invitation issued in December 1958. U.S. funds presently allocated for proposals that have been accepted to date for work in the United States amount to $1,691,589; Euratom has allocated $1,682,800, for work in the community, making a total amount of $3,374,389 for all contracts authorized. As is evident, these figures indicate close adherence to the "matching" principle earlier established to guide U.S. and Euratom expenditures in the joint research and development program.

NUCLEAR TECHNOLOGY AND GENERAL SUPPORT

Mr. RABAUT. Nuclear technology and general support, $49.5 million. You are programing an increase of $5,566,000 in this program. Please tell us where this increase is going to be used and why it is necessary.

Mr. FLOBERG. This is one of the most important programs we have. I will ask Dr. Pittman to expand on this.

Dr. PITTMAN. The importance of the program as a whole is because it is in this area that we are doing all of the research and development work that applies not to specific reactors that are being built but to the solution of the long-range problems that will make it possible in the future to really build cheap and economical reactors. The solution of the problems of what kind of materials will stand up under the environment that reactor operations call for, how to chemically process the fuel elements that are coming out of these reactors, how to dispose of the waste in a manner that is economical, and safe.

DIRECT CONVERSION PROCESS

Mr. RABAUT. Briefly explain direct conversion and tell us what prospects you now see for this process.

Dr. PITTMAN. The direct conversion process simply is a procedure under which electricity can be taken directly from heat. The process we are working on at Los Alamos for direct conversion of heat to electricity is in the early experimental stages. Its future will depend on the research and development program and it will take quite a long time to resolve, sir.

It is certainly a system that we think has great potential merits, and it is in the very early stages of research and development. It has

already shown its practicality in, if you will recall, the SNAP III unit where the isotope was converted into electricity.

Mr. RABAUT. Apparently private funds are being invested in this direct conversion process. Why is it necessary for the Government to involve itself increasingly in this field?

Dr. PITTMAN. There are some private funds that are being spent in this field just as there are in the field of using the more standard methods of converting heat into electrical current.

Mr. RABAUT. Apparently there is a lot of private money going into this. Now does the Government have to involve itself in that?

Dr. PITTMAN. I think where the Atomic Energy Commission must become involved in this program is in those cases where we are trying to use the direct conversion directly in reactor concepts so that it is part of the reactor system. I think it is our responsibility to expend the effort in that field.

Mr. RABAUT. Merchant ship reactors, $8.3 million. I have no questions about that.

ARMY POWER REACTORS

Army power reactors, $15 million. Please explain the remote site study which was not specifically programed in the budget last year, but for which you are spending $515,000 in 1960.

Dr. PITTMAN. The remote site study was one authorized specifically by the Joint Committee in which we were authorized——

Mr. RABAUT. It was authorized but not in the budget?

Dr. PITTMAN. We stated that we had other funds.

Mr. RABAUT. It was under lump-sum study.

Dr. PITTMAN. Yes, sir. This report was submitted on the 1st of April to the Joint Committee of Congress.

Mr. RABAUT. Why should we continue to increase the level of this program? You are this year requesting an increase?

Dr. PITTMAN. You are speaking of the Army program?

Mr. RABAUT. Yes.

Dr. PITTMAN. The increases in the program are to carry out work that will be necessary if we are to get these highly compact reactors that will be required by the military services for land vehicles, reactors that can be put on trucks and carried around rapidly from one place to another.

Mr. RABAUT. Naval reactors, $85 million. I have no questions.

AIRPLANE PROPULSION REACTORS

Airplane propulsion reactors, $73 million. Is there any more prospect of succeeding with this project than there was last year?

Mr. FLOBERG. This is a program which has been going for a good many years. I would say we keep on adding to our stock of knowledge concerning it. The program was, as you know, redirected to some extent last summer. Our job here is to try to respond to the requirements of the Department of Defense.

Mr. RABAUT. We have to take cognizance of this. There is also $75 million budgeted by the Air Force. How long have we been developing this project?

Mr. FLOBERG. We have been at it on varying scales of activity since 1946. Of course, the rate of expenditure in the early years was not as great as it has been in recent years.

Mr. RABAUT. Are we getting any place?

Mr. FLOBERG. Yes, we have made some progress, although I must confess it is discouragingly slow.

Mr. RABAUT. It is discouragingly slow for a terrific sum.

Mr. FLOBERG. That is a correct statement, but it is also a difficult subject.

Mr. RABAUT. Why is the request up for next year when we are making such little progress? It was $62.5 million last year and you are requesting $73 million.

Mr. FLOBERG. Here is the reason for the increase. The increase is attributable to added funds being devoted to the indirect cycle system of furnishing power for flight propulsion. As the committee has been told in the past, there are two approaches to this problem and in a problem as difficult as this, two approaches are not too many. One is the so-called direct system whereby air is run through the reactor, heated and, due to heat, expanded and is expelled as gas or hot air, and power for flight is furnished. The other is the so-called indirect system whereby liquid metal is heated in a reactor and sent to a radiator where air is heated, expanded, and expelled as a hot gas.

Mr. RABAUT. Will either one of them work?

Mr. FLOBERG. Both of them are still in the developmental stages. We are now asking for this increased money in order to try to build a small experiment on the indirect system. This is what all this increase is attributable to. We are at the stage now where we think we can build this and use it as one of the building blocks on which to develop a flight program. That is the total increase in funds.

Mr. PILLION. May I ask a question on this?

Mr. RABAUT. Yes.

Mr. PILLION. How can you spend $62 million? And you have a request for another $73 million. It is a lot of money? How many reactors have been built? Who is getting this money? How many concerns are in this $62 million?

Mr. FLOBERG. If you counted all the subcontractors I would not have the slightest idea.

Mr. PILLION. How many reactors have been built or how far has one reactor gone? What do we get for $62 million?

Mr. FLOBERG. Let me try to say what we get for $62 million.

Mr. PILLION. I am completely puzzled at how lightly we take $62 and $73 million. We get nothing but the most vague answers here as to what is happening to that.

Mr. FLOBERG. I don't mean to be vague.

Mr. PILLION. I know you don't.

Mr. FLOBERG. Let me try to tell you what we get. We are doing materials research, for example, on materials that are supposed to furnish the highest possible temperatures for sustained periods of time. Now, this is a most demanding technical assignment that any material can be given and in fact, we are still trying to invent the material that can do it, and that is what a large part of the expenditure goes to here. One of the reasons that this kind of performance from the materials is required is that the reactor has to be as small as pos-

sible so that the shielding will be as small as possible so that it will be as light as possible so that the airplane will fly.

Mr. PILLION. How many companies are working on this? How many scientists have been working on it? What are they doing? Is it possible to eventually arrive at that?

Mr. FLOBERG. We think it is possible. We figure it is worth while or we would not be doing it. As I say, we are here satisfying the requirements of the Department of Defense.

Mr. PILLION. The Air Force is also spending about $75 million annually on this project.

Mr. FLOBERG. They are spending most of theirs on the engine which will utilize the hot air we can furnish them from the reactor. Building an engine of this scale is no small job, either. Only nuclear flight poses such a demanding requirement.

Mr. PILLON. The Army is spending——

Mr. FLOBERG. The Army is not in this program at all. This is the Air Force and the Atomic Energy Commission. Our part of the job, the Commission's part of the job, is to furnish the reactor that can furnish the heat to the engine which the Air Force is developing.

To answer the specific question as to whether reactors have been built under this program, the answer is "yes," HTR II and III have been built and operated. These were primitive. It will be necessary to build more reactors before we get to this goal.

Mr. CANNON. Might I ask a question there?

Mr. RABAUT. Yes, Mr. Chairman.

NAVAL REACTORS

Mr. CANNON. The committee is very much interested in the naval reactors. We consider the naval reactors program among the most valuable. As a matter of fact, I don't think the country will be safe eventually without nuclear-powered missile-firing submarines. Eventually we must have something to take the place of SAC, and the nuclear-powered missile-firing submarines are the only thing that will serve the purpose. As a matter of fact, within 2 hours after fighting starts, the submarines will be the only part of the Navy left afloat. The submarine cannot be found, and when found, it cannot be destroyed. It can go under the icecap. It can come up anywhere within range of any Russian satellite production center.

Time is running out on the SAC. It has been a wonderful agency, and it served the Nation well in its day of need and is serving it well today, but it is merely a question of time as development proceeds before SAC will be outmoded. We must have something to take its place, and we must have these naval reactors.

This committee is much interested in the naval reactor, much interested in Admiral Rickover, the father of the nuclear submarine who has made it possible.

I don't have to call your attention to the fact that Admiral Rickover is a very remarkable man. He adapted nuclear power to the submarine when all the authorities said it could not be done. He took hold of the reactor up at Shippingport and made a success of it at the time that it was a very doubtful project. He works really under two budgets, under the AEC budget and under the naval budget, and of course,

there is a great deal of redtape, but I think I can speak for the entire committee when I say that we have every confidence in Admiral Rickover. We know he will only spend the money he ought to spend, and we warmly endorse any money that he thinks ought to be spent, and we are very anxious that he receive all the support he needs.

May I, speaking for the committee, make that suggestion both to the Chairman of the Commission and the Secretary of the Navy?

We get the impression from many points of view that Admiral Rickover from time to time is circumscribed by rules and regulations, which are proper and which should be imposed and observed, but the committee has such confidence in him, and he has so often more than demonstrated the wisdom of that confidence, that we are very anxious for you to give him as free a hand as possible with as little redtape as possible.

I would like to ask, Are you giving Admiral Rickover all the support he needs to carry out his very important work?

Mr. FLOBERG. I certainly think so, Mr. Chairman. I know Admiral Rickover well enough to know that if he is not given the support he will find it. I believe he is getting all the support.

Mr. RABAUT. I want to ask a question. How much did the admiral request for 1961?

Mr. FLOBERG. This amount.

Mr. RABAUT. He got what he asked for.

Mr. CANNON. You are giving him all that he asks?

Mr. FLOBERG. That is affirmative.

Mr. CANNON. I trust that in the administration of the AEC and in the administration of the Navy that you give him as free a hand as possible. We realize that certain formalities must be complied with, but we feel that Admiral Rickover can be trusted to carry out any work left in his charge, and we sincerely hope that you will give him every opportunity to carry on.

Mr. FLOBERG. You realize, Mr. Chairman, that between the time these figures were prepared and the time we actually get our appropriations his requirements may vary up or down slightly.

Mr. RABAUT. These figures are correct as of the time he made the request?

Mr. FLOBERG. That is right.

NUCLEAR PROPELLED AIRCRAFT

Mr. PILLION. Last year's hearings contain a discussion on this particular question between Mr. Boland and the chairman of the Commission, Mr. McCone, on the nuclear propelled aircraft. Mr. Boland suggested that we had already spent $1 billion on this program, and Mr. McCone corrected him and said $900 million. Then further in the hearings there is the statement Mr. McCone made on this subject, "At the moment I do not think they have defined"—the military—"a military requirement for a weapons system in which this nuclear-powered plane would be used."

Mr. FLOBERG. That is still a true statement, Mr. Pillion.

Mr. PILLION. How many billions are we going to pour into a situation that may be nothing but a white elephant? That seems to be a tremendous waste of funds and effort. It just seems a tremendous waste.

Mr. FLOBERG. Mr. McCone's statement and the situation today is that no specific weapon system has been designed for a nuclear-propelled airplane. The requirement which the Department of Defense set on us last summer about July or August was for an airplane which was capable of development as a military airplane in a weapon system. In other words, this is meant to be a military-type aircraft, but not one that is all laid out for a combat mission or anything like that. It is one on the basis of which combat mission aircraft could be developed. That is still the situation.

Mr. PILLION. In other words, it is not your idea but is a requirement to you of the Defense Department; you have no idea as to its utilitarian value?

Mr. FLOBERG. We cannot tell them what they can use the powerplant for. They have told us if we develop a suitable powerplant, they will find a good use for it. That is what that amounts to.

Mr. RABAUT. Off the record.

(Discussion off the record.)

Mr. RABAUT. We shall now adjourn until 10 o'clock tomorrow morning.

THURSDAY, APRIL 21, 1960.

NAVAL REACTORS PROGRAM

Mr. CANNON. We were discussing yesterday afternoon the matter of naval propulsion reactors. We shall be glad to have any further information on that subject which the Commission can give us. Do you have further comments to make on that subject?

REACTOR BUDGET

Mr. FLOBERG. Yes, sir, Mr. Cannon. There is one point in the record I would like to clarify and correct. You and one other member of the committee yesterday asked me if the naval reactors budget had been cut, I am not sure of your exact words, or whether we were providing the Naval Reactors Branch with all the money that was requested. I replied that we were, and it had not been cut.

After the session yesterday I went back and rechecked the records, and I find that that statement was not completely accurate. The initial submission by the Naval Reactors Branch for the 1961 budget was $87.5 million. This figure was reduced to $85 million in the budget that is before you. The logic of that reduction I find on my research into last fall's action was that the naval reactors budget in 1959 had underrun by a few million dollars and it is, as a matter of fact, underrunning in fiscal 1960 by a few million dollars. However, within the last few days, Admiral Rickover has expressed a requirement for a budget of $89 million. This is in effect asking for a restoration of the $2.5 million previously cut, plus $1.5 million, or a total of $4 million more than the budget that is before you.

Now, this most recent request has not been screened by the Commission or anything of that sort, but I want to make it completely clear on the record what the present stated requirement of the Naval Reactors Branch is.

Mr. CANNON. Thank you, Mr. Floberg. Are there further inquiries by members of the committee?

The request of $40,300,000 for missile propulsion reactors.

Will you please explain in some detail the Project Pulto, how it will operate, and what its military mission is? It seems to be a very expensive project. Possibly there are situations under which it will be highly desirable to have it. Can you give us information on that?

General LUEDECKE. Mr. Chairman, General Branch, who is the chief of the project, is here. I will ask him to respond to the question.

Mr. CANNON. General Branch.

REACTOR SYSTEMS FOR MISSILES

PLUTO SYSTEM

General BRANCH. The mission of the two reactor systems for propulsion of missiles—there are two code names for these, the PLUTO system, which is a ramjet reactor in which the direct aircycle reactor, somewhat similar to the direct air cycle system used for the aircraft nuclear propulsion system, in that it uses the same fuel air techniques, heats air through the passage of supersonic air through the reactor and out through the nozzle as the ramjet propulsion system. This is designed to operate at the highest efficiency at low altitudes, basically at sea level, and will propel a missile system, unmanned missile system, for an indefinite length of time at these speeds. The system itself, which is a military system which could be tied into this ramjet propulsion device would be called SLAM supersonic low altitude missile, which would be designed as a military system to carry payloads.

At the present time, in the PLUTO program we are working on the reactor techniques themselves, and this fall we will run our first reactor test with this technique in what is called the TORY system, the TORY 2, a reactor system, will be fired at Jackson Flats in Nevada this fall to prove out the feasibility of this system.

ROVER SYSTEM

The other system, which is the ROVER system, is a nuclear rocket which is designed to operate as a standard rocket system, either as a primary stage, or in secondary stages, to fire rockets with high payloads, either into orbit or into space systems. This is a system which is being worked on by the Los Alamos Scientific Laboratories and is a completely different kind of reactor system, also a high density system, in order to provide this power.

You may have heard an example of the power density of this particular reactor which is exemplified by saying that a reactor of this density, which is the size of an ordinary office desk, puts out about the same amount of power as Boulder Dam. These power levels would be harnessed into a ROVER jet system—jet rocket system—which would have a long time thrust, which is interesting and useful in this particular case to NASA and potentially of course to the military to be used for space systems or orbital systems of propulsion.

Mr. CANNON. The committee is deeply interested in the development of all species of missiles. Apparently eventually, we don't know how long, but eventually it will be the weapon depended upon for both

defense and offense. We would like to make as rapid progress as possible in this missile.

There seems to be a good deal of difference in ROVER and PLUTO. Both are apparently comparatively recent developments.

General BRANCH. Comparatively, yes, sir.

Mr. CANNON. Did they originate about the same time? Which is the older of the two?

General BRANCH. About the same time, 1956.

Mr. CANNON. The comment that we get on PLUTO is that it is rather intricate, that it is expensive, and there is some question as to just when it will be ready. The ROVER we must have for the sake of space power. What is the recommendation of the Commission on these two projects?

General BRANCH. The recommendation of the Commission for funding in the ROVER program is $21 million as an estimate for fiscal year 1961. In addition to this, there will be $13 million in fiscal year 1961 for facilities.

Mr. CANNON. What do you estimate will be the total cost for ROVER and how soon before it will be operational?

General BRANCH. We have spent already on the ROVER program $145 million through 1961. Through 1965 we will have spent, or programed to have spent, $231,700,000. This is aimed toward full flight test in 1965.

Mr. CANNON. And when it reaches the stage of full flight test, it would be used in the NASA system?

General BRANCH. Yes. It would go into the NASA system for space propulsion, rather than into specific military armament.

PLUTO SYSTEM

Mr. CANNON. Some of our scientists seem to be a little bit dubious about PLUTO. You are asking $19 milion for it. I believe in the present budget.

General BRANCH. Yes, sir.

Mr. CANNON. What do you anticipate to be the total cost when fully developed?

General BRANCH. Through 1961 it will be $95,700,000, including Air Force funding.

Mr. CANNON. Is success in developing PLUTO for the purpose for which it is expected to be used fairly likely?

General BRANCH. Yes, sir. There is every indication that we will be successful. Our first feasibility test, the Tory 2–A test, will be conducted this fall, at which time we will have ample proof that we properly designed our system and will have checked it out.

Mr. CANNON. One objection which has been voiced is that it would fly at very low altitude and would have to fly over densely populated areas. On that account there would be constant danger of widespread disaster. What about the safety feature of it?

General BRANCH. There are being designed into this system safety features. In the first place, the fission product release part, or the consideration of fission product release as a safety consideration, is being looked at very carefully with the direct air cycle engine system for the manned aircraft. It uses the same basic type of fuel ele-

ments, although in this particular case the fuel elements for the Pluto are uncoated and, therefore, the fission product release rate is somewhat higher. However, it is possible to calculate the fission product release rate and to determine that this is not an unacceptable rate when flying over populated territories.

Mr. CANNON. Apparently, there is little question about ROVER. It is generally conceded that we must have ROVER.

SATELLITE POWER SYSTEMS

Mr. CANNON. Satellite power system, $14 million. Can you outline for us the schedule of operational dates for the various air systems for which the SNAP devices are being developed?

General BRANCH. This is Lieutenant Colonel Bicknell, head of the Missile Projects Branch of our office.

Mr. CANNON. Colonel, we will be glad to hear from you.

SNAP DEVICES

Colonel BICKNELL. SNAP 2 is our three-kilowatt electrical system, the first one being built for the Air Force, is scheduled to be operational in the calendar 63–64 time period. The SNAP 8 is a 30-kilowatt system for NASA. It is supposed to be operational in 1965. The 300-watt SNAP 10 system for the Air Force is supposed to be operational about 1963. We have several other systems on which we are negotiating with the DOD in order to get firm requirements: For those, operational dates will be set after firm requirements are established with DOD. Our reactor systems are SNAP 10 for 300 watts, SNAP 2 for 3 kilowatts, and SNAP 8 for 30 kilowatts.

Mr. CANNON. The value of the satellites we have been sending up is, of course, necessarily dependent on the mechanism which they carry with them. Our understanding is that this device is to be enclosed in satellites to provide the power for all of the registering machinery. What is being used now for that purpose, for example, in the TITAN or the TIROS or the other satellites we are sending up. You say this will be 1963 or 1964 before it will be developed, but all the satellites we have been sending up are packed with machinery. What are we using? What would this device, when completed and perfected, supersede in the satellites we have been sending up recently, and expect to send up between now and 1964 and 1965?

General BRANCH. Fundamentally there are two power sources for devices that are putting out signals now; chemical batteries and solar energy converters. In general, solar batteries operate a trickle charger which charge up the battery storing up the energy, and this energy is triggered off in peakloads at periods sufficiently far apart so that the trickle charges from the solar battery allows the chemical battery to restore its energy.

Mr. CANNON. That is the present system.

General BRANCH. The present system. We do not have at the present time any nuclear systems that are providing power in any satellite devices. The primary advantage to nuclear power, SNAP devices, is that they can put out this energy for very long periods of time, depending primarily on the half life of the isotope in the case of radioisotope heat sources or power sources. They will be a much

less complicated system and for the amount of power that is put out, they are much lighter in total weight when you get into fairly large power sources. You run out of efficiency in power available versus total weight of the system very quickly in the chemical batteries, and to a certain extent——

Mr. CANNON. Once the battery is exhausted, your mechanism is dead.

General BRANCH. Yes, sir.

Mr. CANNON. This would prolong its life how long?

General BRANCH. For an indefinite period. In the case of reactor power sources, the small reactors, the life is determined primarily by the life of the rotating mechanisms that this reactor system operates, and these rotating mechanisms have already operated under test for many, many hours, hundreds of hours. There is no reason to believe that these things can't last for a year or more with continuous power.

Mr. CANNON. As far as you are aware, have the Russians depended up to this time on chemical batteries? or have they attempted the adaptation of nuclear power for operation of the internal mechanism of the satellites?

General LUEDECKE. Mr. Chairman, I don't believe we have any information that they have attempted to apply nuclear power in this sense. I am not aware of any information that we have on that.

Mr. CANNON. As far as any member of the staff of the Commission knows, the Russians have not attempted to utilize nuclear power internally in their satellites?

Mr. MCCONE. We have no evidence of that during our visit to the Soviet Union, nor when their scientists were here. The subject was broached several times but there was no statement which would lead us to that conclusion.

Mr. CANNON. Diverging just a little, we have been told that the Russians have attempted to send up a man in one of their satellites. Have you any information on that?

Mr. MCCONE. No; there has been some gossip and columns appearing in magazines and one or two articles in the papers. We have no information on that at all.

Mr. CANNON. The information we got was to the effect that the conclusion that they had attempted to send up a man was purely a matter of deduction based on the fact that they had trained a man and had put him through many tests and attempted to condition him in every way possible for such a trip and the reason for believing it was not a success was that the man had not since been seen. That was pretty good evidence that it was a failure, if there was any foundation for the original report. You have nothing definite on that?

Mr. MCCONE. No; we have the same type of information which we attribute to gossip. We have no sound information to back it.

OPERATIONAL SERVICES AND EQUIPMENT

Mr. CANNON. Operational services and equipment, $22,800,000. Insert in the record at this point the tabulation showing estimates and actual costs in this entire reactor program for each of the last 5 years.

General LUEDECKE. We will do that, Mr. Chairman.

(The information referred to follows:)

REACTOR DEVELOPMENT PROGRAM—COMPARISON OF AMOUNT AVAILABLE WITH ACTUAL COST EXPERIENCE

Operating costs

[Millions of dollars]

	Amount available	Actual	Difference
Fiscal year:			
1955	$87.1	$95.3	$8.2
1956	134.6	161.5	26.9
1957	285.3	270.4	−14.9
1958	357.3	328.9	−28.4
1959	414.5	376.0	−38.5

Mr. CANNON. Any questions on the part of the committee? The gentleman from Massachusetts.

NUCLEAR-POWERED AIRCRAFT

Mr. BOLAND. I would like to ask first whether or not the Commission is satisfied with the progress on the airplane propulsion reactor compared with the amount of money we have spent in the area.

This started long before you came with the Commission, Mr. McCone, but this is a program that I think gives not only many Members of Congress but many people who have some knowledge in this field some concern. It has cost now over a billion dollars. I presume by the time we get it up there it will cost another billion. And it will be a slow lumbering giant. This is all testimony which has developed many times, but I thought I would detail that again for the record. It will not be difficult to take down. May I ask first, is there a military requirement for it? I think I asked that question last year. I ask it again this year. Is there a military requirement for the airplane propulsion reactor as determined by DOD?

REQUIREMENTS FOR NUCLEAR-PROPELLED AIRCRAFT

Mr. MCCONE. In response to our persistent request to the Department of Defense, they have stated that they would envisage requirements which prompt the continued development of the nuclear-propelled aircraft. Furthermore, they have requested that this be developed along two lines, the direct and the indirect cycle.

Mr. BOLAND. May I just ask, the indirect cycle is fairly new; is it not?

Mr. MCCONE. The indirect cycle is the more recent one. The direct cycle is the one in which the air is passed directly through the reactor and then into the turbine. Both offer significant promise and both offer very great difficulties. The indirect cycle offers a promise of having a more compact and smaller and somewhat more easily shielded device, and therefore a lighter airplane and higher performance. The direct cycle offers a simpler arrangement because it would not be dependent upon containing a liquid metal at a very high temperature.

Mr. BOLAND. Is the Commission satisfied with the rate of advance with respect to this program? This program is now getting to be an old program. It seems as if we are just shoveling the money out.

We have no quarrel with the Commission on it. If you have a requirement for it you do what you are asked to do. I certainly have some misgivings about it.

They have had to build a hotbox, shield the plane, shield the crew, and finally shield the field. Is the Commission satisfied with the rate of progress as compared to the amount of money which the taxpayers are pouring into this program?

Mr. McCone. No; I think this program has suffered through the years, going back into the late forties, when it first started, because it has changed in its direction a number of times. There has been hesitation from time to time as to whether there was a need for the plane, a nuclear-powered plane, and, if there was a need, just what characteristics were sought.

Now, we had progressed quite far up to last June or July with the type of development in both direct and indirect cycles which was approaching the point where we could say with assurance that either system would work, that the technical problems in at least one system were pretty well answered. The performance of the plane would be very poor, indeed, because the temperatures would be relatively low, and the speed of the plane would be to that extent dependent to a considerable extent on temperatures. The Department of Defense made a very thorough review last June. They determined that their requirements as they developed were going to call for a plane that would fly at a speed approaching the speed of sound, and therefore in submitting their requirements to us they in effect instructed us to work on systems that would produce higher temperatures and therefore higher performance planes.

It required us to reprogram our effort in the direct cycle, to abandon the reactor concept, and the particular material that we were to use in the core, and to go immediately to a more advanced material which required a very considerable amount of development, really into a new frontier.

In connection with the indirect cycle, it called for us to go to a higher temperature of the coolant and this presented a problem as to how to contain it. We therefore had to develop the containing material for the circulating system and develop techniques for fabricating that material.

This was last June. Since then significant progress has been made in answering both of those problems. We have questioned as to whether both should be developed or one should be dropped. The answer has been that at some time it is probable that one will be dropped, but right now we do not know, we cannot say, the Department of Defense cannot say, that the unsolved problems in either system are possible of solution. Until we know that, we cannot make our selection.

Mr. Boland. Is there any particular date fixed for the flight of an airplane propelled by nuclear energy?

General Branch. Assuming that we pass certain frontiers and we are sure we are going on a proper feasible basis, we can fly in a ——— time period. It makes a great deal of difference what we decide to do at this time.

Mr. Boland. And what you fly.

General BRANCH. We have been given a requirement to provide powerplants that will fly a specific kind of airplane. The airplane is a modification of what was called a 54-type airplane, an airplane made for a military weapon system called CAMAL, which was a continuous airborne missile launch system which Mr. McCone mentioned was given a reappraisal by the Department of Defense last June and was canceled. This military weapon system was canceled, but the kind of airplane that was being developed for this weapon system was designed specifically to use nuclear power and to be acceptable to the perculiar problems of nuclear power and shielding and so forth.

Mr. BOLAND. You are familiar with this conversation in this field, of course. Isn't there some real skepticism on the part of people who have tremendous knowledge with respect to nuclear-propelled airplanes that this is not feasible, that it will not work?

General BRANCH. There is considerable skepticism among people who know something of it. Let me tell you what the characteristics are which the powerplants we are developing are designed to meet.

We have a guidance—the Department of Defense has a guidance. The Air Force and Navy were told by the Department of Defense, by Dr. York, that they were to work on engine systems which would provide flight in this 54-type aircraft at certain speeds and cruising altitudes and to have a specified useful life under these conditions. This was to be an intermediate, in effect, research and development step, that would be taken, at which time, having taken this step, the military would decide what specific military systems they would tie this research and development vehicle to Within the Aircraft Nuclear Propulsion Office we have set up certain ground rules in addition to these rather loose ground rules we have. For example, we have decided we would not build a powerplant that would make an aircraft in excess of a certain weight. The reason for this is that the Air Force in the B–70 program is addressing itself to an airplane with a certain maximum gross, and we are staying under that limit just to take care of airfield limitations among other things.

Now, with the direct air cycle system as we presently know it, we can provide flight with the system we are working on now provided we can meet the two points in proving out the feasibility of this reactor system and coupled with an engine to fly a plane that will meet these criteria.

Right now the design weight is not for military purposes, but rather for research and development flexibility, and to be sure we have an ability to increase weights in ways we do not now anticipate.

If we can solve the plumbing problems, the very difficult mechanical problems in the indirect cycle system being worked on by Pratt & Whitney, if we can solve the very complicated mechanical problems, and we have no reason to believe we cannot solve them, but we have to keep working on them, we can fly a plane that will probably be lighter for the same airplane. We probably can fly this in the time period if all of the things that we hope to prove are in fact provable in this time period, and we have no reason to believe that they won't be.

In the indirect cycle system——

Mr. CANNON. And you have no positive assurance that you will?

General BRANCH. We have positive assurance, yes, sir, that the things that we are trying to do as first steps are in fact achievable, and having achieved those, we are reasonably sure that we can get on with the rest of it. In other words, we are not trying to do something now that we know cannot be done.

The potential in the indirect cycle——

Mr. CANNON. Are you trying to do something you are certain can be done?

General BRANCH. Yes, sir.

Mr. CANNON. With time and money?

General BRANCH. We are certain that they can be done, but many of the things we are trying to do have not yet been done.

Mr. CANNON. I would like to have the attention of all members of the committee because this is a very pressing problem. We have now spent $1 billion. We must now spend in addition to that another billion dollars. Now, the question before us is, having spent the second billion dollars, having developed a plane of this character which will be a sitting duck which missiles can pick up at any time, will the psychological effect, which will be tremendous, be worth what it is going to cost us, and will we will then have achieved even under the realization of every optimistic hope.

May I read to the committee what Admiral Rickover said a year ago. He said:

> As you know, this is not my responsibility. I believe that Chairman McCone and the Joint Congressional Committee and the Secretary of Defense have that problem under consideration right now. I think Mr. McCone is the proper man for you to ask that question. In my opinion it is a very difficult problem and probably the difficulties are not yet fully understood. I believe it will take longer to accomplish it than even the optimists now say. It is very, very difficult. It is more difficult than anything I am undertaking.

Then he was asked:

> But you think it can eventually be solved?

Here is his reply, practically the question we have asked today:

> Yes, sir. There is no problem of that type that cannot eventually be solved.

That is what we have just been told.

> But you have to decide whether you are willing to pay the price to solve it and whether it is worth the price.

In other words, shall we put in another billion dollars.

Now, that is the problem before us: Is it worth the price? If we spend another billion dollars, and do develop a plane that will fly it will be susceptible to attack. It would not possibly survive in case of allout war. Admiral Rickover continued:

> The issue is for the Defense Department to decide whether it really wants it. I am not certain whether the Defense Establishment has decided.

Would you say they have decided at this time, Mr. McCone?

Mr. MCCONE. No, I cannot say that they have positively decided. Their decision seems to me to be along the line that this plane, as presently being developed, will be a higher speed but irrespective of that, it would not be in the supersonic speed class. Nevertheless, they have, it appears to me, decided that the potentialities of a plane of unlimited range are such that while they cannot specifically identify an outline of weapon system at this moment, it is worthwhile developing with the

idea that as these new and exotic and different things are developed, their use becomes more and more apparent. That seems to be the position of the Department of Defense at the moment.

I think, however, if there is a question in the mind of this committee, it might be worthwhile for you to ask Dr. York to come in and explain their current thinking. From the standpoint of the Commission, our views are that we are making a concerted and determined effort to accomplish this mission. We think that a plane so produced will have great growth possibilities. We think it is very difficult to see the future of such a development.

Furthermore, what we are doing adds substantially to the technology in this field, because of the very high temperatures and the new and different materials which must be developed, the new and different reactor concepts. There is a great contribution to this whole area of nuclear science which is our responsibility. We are supporting this program at the level that we have it in this budget. We think, with time, important results will be attained. However, the Commission does not wish to in any way discourage the hopeful optimism of the staff, and we welcome their setting these goals because without goals progress is not made.

Mr. CANNON. You are saying that you are not asking for it.

Mr. MCCONE. I would be less than frank with you, Mr. Chairman, if I did not tell you that it is extremely difficult in our mind to forecast by date when technical problems yet unsolved are to be solved and incorporated into such complicated devices as nuclear propelled aircraft. I think that represents the view of Mr. Floberg, who has gone into this thing probably in more detail than any one of the Commissioners.

Mr. FLOBERG. Yes, sir. I feel that the dates which have been stated to the Commission are based on assumptions, as all prophecies must be, and there is considerable optimism which has been ground into them. I would not be bound by these dates at all. If you ask me what the date would be, I would say, assuming that we get good luck, reasonably anticipatable good luck in the technical problems, that those dates are a couple of years optimistic.

On the other hand, Mr. Chairman, if we were satisfied with the performance, of the kind that you have described, I believe that we could have achieved that flying article maybe by now. This has been the kind of performance, however, which has now been rejected and we have upgraded the performance requirement. It is going to take us a good many years, I believe, even if we get reasonably good breaks along the line, and come to no insuperable obstacles, and I must say no insuperable obstacles have been identified, to come up with a finished product.

This is not a system of airplanes or general capability. This is just the initial step toward developing a system of aircraft.

Mr. BOLAND. Which is expensive, of course.

Mr. FLOBERG. It is like any other aircraft system. You are familiar with how long it takes to get from the prototype of a conventional airplane to having that aircraft in useful numbers. This is always a period of 2 or 3 additional years at a minimum.

Mr. CANNON. We are aware that the Russian Government has discontinued some time ago the production of manned bombers. Now this thing resolves itself into a rather simple problem. We have spent a billion dollars on it now. It will be necessary to spend another billion dollars on it, and, gentlemen, our billion dollars are getting a little scarce now.

Admiral Rickover says for us to inquire of Mr. McCone and we have inquired of Mr. McCone, and then he says, "You have to decide"—the committee will have to decide "whether it is willing to pay the price to solve it," and whether it is worth the price if it is solved. That is the nub of the problem.

"In my opinion you should find out from the Secretary of Defense whether he really wants it."

Now, that statement, "whether he really wants it" is significant, because nobody seems to want it. It is an orphan child, left on the doorstep.

Nobody seems to have the nerve to stop it. So if it is stopped, it is up to this committee to stop it now.

Mr. BOLAND. Let me say the Commission has been given the job and it is doing its job to the best of its ability and in the best practical time. I appreciate it. I think the Commission has done a wonderful job. I think at times it does jobs with misgivings, but it is told to do it. I agree with what Mr. McCone has brought out on the basis I heard Admiral Rickover's testimony before our committee, and I think that the Department of Defense itself is the proper place to ask the questions as to what the military requirement is, and whether or not we ought to spend the money and whether it is worth the price. My question is what good will it be when we get it up there. That is all.

Now I have the same problem with PLUTO. PLUTO is a weapon. It is really a missile, is it not?

General BRANCH. Yes, sir.

PLUTO CAPABILITIES

Mr. BOLAND. What can PLUTO do that the conventional missile cannot do?

General BRANCH. In the first place, there is no known adequate defense against high-speed low-altitude missiles.

The military people are enthusiastic for the PLUTO missile system.

Mr. BOLAND. They are enthusiastic over all kinds of systems where we spend money. We find that is true. But how about people outside the military? How about scientists and physicists who are working in this area? Isn't there a real split of opinion as to the worth and value of this particular weapon as compared to the conventional missile?

General BRANCH. One scientist-physicist, for example, Dr. Edward Teller, is extremely enthusiastic about this system.

Mr. BOLAND. This is out in Radiation Laboratory. They are developing it. They are requesting a good part of $19 million for next fiscal year. Of course, he is enthusiastic. I have never bumped into a college president who is not enthusiastic about a project for which we

give money. Outside of Dr. Teller, and with respect to other physicists and scientists away from the Livermore Radiation Laboratory, isn't there a real split of opinion as to whether or not this is worth the cost we are putting into it as compared to what the conventional missile will do?

General BRANCH. Yes, sir: I think that there is in the same way as there is split of opinion on almost any controversial subject.

Mr. BOLAND. But there is a real split of opinion on this subject. I think it would be a good idea, Mr. Chairman, to invite Dr. York to appear, and others who are familiar with this program, and to ask them the same question with respect to PLUTO as we might ask in respect to the nuclear-propelled aircraft. There is a great deal of concern over PLUTO because of the fact that it only flies at low altitude, at 1,000 feet with the hazardous conditions and, apparently, the radiation which will be spewed. This is a real problem, is it not, with PLUTO?

General BRANCH. Yes, sir.

Mr. FLOBERG. It is a real problem, Mr. Boland, but let me come to the assistance of General Branch by saying that this missile has the advantage of being previously airborne which other missiles don't have. In other words, it partakes of the POLARIS advantage of not being destroyed before it can attack, plus the fact that it is virtually invulnerable to destruction, and the POLARIS missile as well as any other ballistic missile, at least theoretically, is destroyable.

Mr. BOLAND. Are we satisfied that we ought to go ahead with this program? Are we satisfied if we develop the PLUTO missile where it will be operational that this will give us something better than anything we have had in the conventional system?

Mr. FLOBERG. Yes, sir; there is a split of opinion as you have identified. I am on the side that says this missile is worth the effort.

Mr. BOLAND. Mr. Chairman, I would like to quote the following opinion concerning Project PLUTO:

> nuclear propulsion and nuclear power sources for space travel are highly desirable objectives but their propulsion for missiles can be better achieved with chemical fuels.

This same opinion was expressed by still another group which did all the earlier studies on nuclear propulsion for missiles and recommended against it. These opinions would seem to throw some question on the desirability of continuing with PLUTO.

> Against this appears to be a general recognition of the need for a low-flying, terrain-controlled delivery vehicle. Military requirements for and the feasibility of PLUTO should be explored thoroughly in connection with funds requests for 1961.

These are the opinions of two eminent highly respected scientists and physicists. It is in the record, Mr. Chairman. That is all I have.

Mr. FLOBERG. I don't question that those opinions exist.

Mr. BOLAND. As I say, I appreciate the position of the Commission, very much.

Mr. CANNON. The gentleman from New York, and I would like to ask the gentleman if he would favor us with a comment on the nuclear-powered airplane first.

Mr. PILLION. That is exactly the matter I would like to address myself to, Mr. Chairman.

NUCLEAR POWERED AIRCRAFT

In regard to the nuclear powerplant for aircraft, we have discussed its specifications.

General BRANCH. This is the specifications for a research and development vehicle, not military aircraft. It was not Dr. York's intention when he specified these flight performances that it would be a military weapon system.

Mr. PILLION. No; but it is a powerplant regardless of where it goes; is that right?

General BRANCH. Yes, sir; that is the first step. It is the learning step by which you can make application.

Mr. PILLION. Now, our present latest bomber plant, the best plane that we have, has a speed of how much?

General BRANCH. The best airplane we have now has a speed of mach 2. That is the B–58 bomber.

Mr. PILLION. That is how many miles per hour?

General BRANCH. That is about thirteen hundred to fourteen hundred miles an hour for the B–58, which is a mach 2 bomber.

Mr. PILLION. Now, how high will our present planes fly?

General BRANCH. In excess of 50,000 feet.

Mr. PILLION. This is not designed to fly that high.

General BRANCH. It is not designed to fly at high altitudes.

Mr. PILLION. We now have planes that fly at 1,400 miles per hour and in excess of 50,000 feet. So that you are spending all this money for a plane that has a performance that is not nearly equal to what you already have in the other type; is that correct? I know the design is different. I am talking about the practicality. We are in this not talking theory; we are talking practicality. How much less vulnerable will this new plane be to missiles than the present planes that we have, or are they more vulnerable?

General BRANCH. If you were to fly this new plane we are talking about in the same way that you flew the B–58 bomber, for example, it would be more vulnerable. However, no nuclear-powered airplane of this general type, if it were a military system, such as the CAMAL weapons system was designed to do, was designed to fly, to live in the same kind of atmosphere that a high supersonic bomber would live in. The idea is that it would stand off away from heavily defended territories and lob in missiles that it would have a definite airborne alert capability, and it would not have a vulnerable base from which to operate, because it would have been launched and airborne before any hostility. The idea is it can launch missiles at any time. It does not have to penetrate enemy defenses. It has a growth potential both in supersonic speed, and in low altitude dash capability, rather much of the same advantage we talked about earlier in the SLAM weapon system. There are studies going on concerning the sircraft, and using the growth of the indirect-cycle weapon system being developed by Pratt & Whitney on the assumption that one can assume the things that Pratt & Whitney is trying to achieve under a normal growth with the indirect-cycle system, this B–70 could fly, with present aircraft manufacturers' calculations, and there is no reason to believe that these calculations are biased.

This is under certain specialized aircraft configurations and with certain reduced payloads.

Mr. PILLION. Frankly, I am not very much impressed with the recital here of the benefits and advantages of this plane over that of the present type of planes. When you weigh the disadvantages against the advantages I am sure there is very little to be said I think for this type of plane.

On the other hand, as far as I am able to judge, you were given a specification for a plane here, and then you say the use of it in the future has not been determined, a civilian or even a military use. I don't know. I don't think anyone knows, as you say here yourself, the actual use of this plane. I certainly join the chairman and the gentleman from Massachusetts in wondering about the practicality in spending this amount of money, whether this is the most urgent need of our defenses. As far as I can see, I find very little great advantage from the military point of view in the future of this type of plane. It is slow. I don't consider the advantages you cite here to be great advantages. How many missiles will it carry?

Mr. MCCONE. I wonder, Mr. Chairman, if we are not getting into a field that is beyond the competence of the Atomic Energy Commission in the way of justification of a plane from the standpoint of defense. Our role is to develop these devices.

Mr. PILLION. I am not criticizing the situation from your point of view. I am criticizing it from the point of view of policy of the Defense Department or the committee. We have the ultimate responsibility for determining where our money will be best used from the practical point of view for defense. I think that is exactly what the chairman, the gentleman from Massachusetts and the other members of this committee are thinking. It will be a waste of money if we are merely attempting to develop a plane for the purposes of theory, for the purposes of civilian use as distinguished from military use. I think the spending of this kind of money is not justified unless we know that it is an urgent defense situation where we will increase our defense abilities and capabilities. But just for mere theory and just merely perhaps finding a plane which is going to have a different powerplant is not in my estimation an aid to our overall defense posture, our overall defense strength. I think it is a dissipation of tax money, dissipation of energies on the part of your scientists, your engineers, and your defense.

The overall primary broad problem of course is not yours. It belongs to this committee and to the Defense Department. I certainly recommend that somebody from the Defense Department appear before this committee for the purpose of justifying it from the military point of view. Because of the tremendous expenditure, we should place that money where we can get defense in the next year or two or three against the Soviet threat so that we have not a theoretical supremacy 10 years from now, but an actual, practical weapon superiority today, tomorrow, and the next year. That is what we need, not theoretical imagination.

Mr. CANNON. I thoroughly agree with the gentleman from New York. And may I say for the committee, and I am certain I express the opinion of every member of the committee, that the Atomic Energy Commission is entirely within their province in what they have

given us. And again may I say that every member of the committee deeply appreciates the efficiency and the work of this Commission. We trust you will permit us to fully collaborate with you and as we go along to express personal opinions as we have today. As the gentleman from New York well says, in the last analysis, it is the committee that will make the decision. We want to make it, of course, on the advice of the Atomic Energy Commission and within the purview given us by the Defense Department. But we do understand that you are perfectly within your province and we do appreciate, every one of us, what you are doing, and the admirable way in which you have cooperated today on this question.

This committee understands now that anything useful today will be obsolete 5 or 6 years from now. There is hardly a weapon or system in operation today that will not be outmoded 5 or 6 years away. We are told that the Strategic Air Command, SAC, will be obsolete and ineffective in the next year or two, possibly, certainly in 5 or 6 years. When you compare the present effectiveness of SAC with what we are promised here in 5 or 6 years, I hardly think we will have made much improvement in spending another billion dollars.

As has been said, we must take every care to be certain that the Russians do not, as they have promised us, and have predicted, defeat us economically as we spend ourselves into bankruptcy and fall like a ripe apple into their laps.

We must take into consideration from now on with increasing care, every billion dollars of expenditure we make in the future. The Secretary of the Treasury in recent weeks has been doing everything possible to sell $2 or $3 billion worth of bonds. He has offered them at 5 percent, 4¾ percent, up and down the line, but nobody wants them. If the Secretary of the Treasury cannot sell the bonds when we spend more than we take in, where are we to get the money? In what condition will we find ourselves with Russia watching us on the other side and expecting us to bankrupt ourselves by the expenditure of money which will not bring back to us anything like what it is costing us?

Mr. Jensen.

Mr. Jensen. I agree with everything our chairman has said with respect to our fiscal condition. We are in a most dangerous squeeze today. The Secretary of the Treasury appeared before this committee. When he got through, I am sure most of us were pretty scared and decided that we should do our best to keep the American dollar stable, which we can't do unless we bring to a halt all unnecessary spending. That is the responsibility resting on the shoulders of 50 men, members of this committee, to a greater degree than any other 50 men or 50 million people. Most of us feel very sincerely about this.

Now, getting back to this nuclear-powered aircraft plant, it would appear that the Pentagon believes that an aircraft of that nature is worth the money and the effort from the standpoint that it will be a plane that stays in the air an indefinite length of time, and from that nuclear-powered aircraft would be discharged missiles of every nature. But I have my misgivings, as I am sure every other member of this committee has, after having heard the testimony given by the Atomic Energy Commission staff. I certainly hope, Mr. Chairman, that we can bring Dr. York before this committee so that we may

question him at length until we are satisfied whether or not this thing is worth the money that we will be obliged to spend for it. This is a matter which has to be handled in a very businesslike manner and to the highest degree of our good American commonsense.

So I want to say that I hope that Dr. York will be brought before the committee, Mr. Chairman. That is all.

Is my assumption as to the potential of this nuclear-powered aircraft about right, or how far off am I?

DISCUSSIONS WITH DEPARTMENT OF DEFENSE

Mr. McCONE. Mr. Jensen, many of the questions that have been raised here were raised by the Commission, itself, with the Department of Defense. The fact is I would say, Mr. Chairman that all of them were raised. We had long conferences and asked for the most specific statements that they were willing to give to us concerning the military applications of these several developments we are talking about, the indirect and the direct cycle, manned aircraft, and the PLUTO program, and we also had similar conferences with the Space Agency concerning the ROVER program.

I have tried to reflect to you the justification and I think that it would be most constructive if Dr. York came before this committee.

I feel, and I would like to tell you, Mr. Chairman, there are two aspects of this from the standpoint of the Atomic Energy Commission. One is the development of stated requirements in the field of our responsibility for the using agencies. The other is the fact that we recognize that in all four of these areas there are great scientific and technical consequences that can come from the successful development we are undertaking.

I have mentioned that there are new and different reactor concepts, and new and different important material developments. This is one of the real frontiers of science and of the application of the atom to new and different uses. I don't think it is possible to foresee precisely where we are going. Now, that of course must be taken into account by your committee in weighing these very important fiscal matters, and I share the concern expressed by the committee in that respect. However, throughout this budget there are many millions of dollars for research in various fields. While this is a question of application, it likewise is a question of extremely important research and I would urge that not be overlooked. We are deeply conscious about the cost of these things. We have screened them and wirebrushed them and brought them down to a point where we feel that if they are cut lower, they would really be retarded and stretched out in a way that would raise a question as to whether they should be pursued at all.

It is not easy to see where these are going. I would point out that when Admiral Rickover came before you and you supported him with large appropriations for the first nuclear submarine, no one thought that the POLARIS would be the outcome of it, and that you were creating at that time what appears to be one of the very important elements of our strategic system.

Now, I am not forecasting a nuclear manned aircraft will have any such future, but it is just a little example of the fact that you cannot always tell where you are going 10 years hence.

Mr. CANNON. Thank you, Mr. McCone. I might say at this point that the committee is profoundly impressed with the work and the attitude of the Atomic Energy Commission. We are especially impressed with the splendid teamwork, cooperation, and collaboration of the Chairman, the Commission and its staff. We have every confidence that when we need scientific information on this subject we can get the best that is available from the Commission and its staff.

The gentleman from Tennessee, Mr. Evins.

Mr. EVINS. Mr. Chairman, Chairman McCone has just about said what I had in my mind to say. I do not wish to be a dissenter from our committee and certainly we have great budgetary considerations that this committee must consider and for which we are responsible. But he has pointed out Admiral Rickover's discovery and my mind goes back initially to the time when you as the distinguished chairman of this committee, and I understand the former senior Senator from my State, were called to the White House and the Department of Defense and asked to appropriate the initial $1 billion for the atomic energy program and you were told that this was something not completely certain or developed. You were told that this might be a waste of money, this might be a waste of a billion dollars. But, you were told, in effect that if it were a success it might well shorten the war and save lives and this might produce both a weapon for our defense and a valuable tool for peaceful purposes. Yet you and the Senator from Tennessee took the gamble and appropriated the billion dollars with the great scientific discoveries and results that followed. So while we have budgetary considerations, I hope that our committee will not close its mind to the future in this field.

We are told that the speeds are going to be lower and that the altitude will be less than already attained, as the gentleman from New York has pointed out. But we should consider also that once you have developed this core of perpetual motion, you won't have to be refueling in the air and it could be the freight car that could carry our cargo while the other weapons provide the direct means of defense. We want to be practical about this matter. If it is not practical, if it is not sound financially, I for one will want to go along and vote to cut the money out and discontinue it and say we have gone far enough. But, while the Chairman and the Commission have pointed out the difficulties involved, I rather gather that they are recommending it because it is carried in the budget.

PHYSICAL RESEARCH

Mr. CANNON. We shall take up the subject of physical research for which the budget requests $163,200,000. We will insert pages 146 through 168.

(The justification is as follows:)

PHYSICAL RESEARCH PROGRAM—OPERATING COSTS

Program statement

Estimate fiscal year 1961	$163,200,000
Estimate fiscal year 1960	143,344,000
Increase	19,856,000

The physical research program includes investigations in the fields of physics, chemistry, metallurgy, and controlled thermonuclear research. The investigations undertaken are for the purpose of discovering natural laws relevant to the Commission's responsibilities for the development, use, and control of nuclear energy. In retrospect, every advance made in nuclear energy capability can be traced to research investigations of the type conducted under this program.

The amount of $163,200,000 estimated for fiscal year 1961 is to meet only the most pressing research requirements. About two-thirds of the program costs are associated with the support of research conducted in Commission-owned major research centers. In fiscal year 1960 approximately 2,500 scientific man-years are engaged in research under this program in the Commission's major research centers with program costs estimated at about $102 million. It is estimated that costs at major research centers will increase in fiscal year 1961 to approximately $114 million in support of about 2,800 scientific man-years. The remaining one-third of the program costs are associated with research conducted at educational institutions, nonprofit research institutions, industrial laboratories, and other Government agencies.

The major portion of the research conducted at sites other than Commission-owned major research centers is conducted at educational institutions. In fiscal year 1960 about $35 million will be expended at educational institutions for research involving approximately 1,000 scientific man-years plus the services of approximately 1,700 graduate students employed as part-time research assistants under the research contracts. Research costs of about $42 million are included for educational institutions in the fiscal year 1961 estimates involving approximately 1,300 scientific man-years plus the part-time employment of an estimated 2,000 graduate students. Approximately $1.8 million will be expended at industrial laboratories in fiscal year 1960 involving approximately 70 scientific man-years and about $0.8 million will be spent at nonprofit research institutes involving about 40 scientific man-years. No appreciable changes are expected in these portions of the program in fiscal year 1961.

Research carried on by other Government agencies in fiscal year 1960 is estimated at approximately $4.0 million with no appreciable change contemplated in fiscal year 1961. (Note: The U.S. Geological Survey in fiscal year 1961 is requesting funds within its own appropriation for the geological and geochemistry studies of uranium formerly budgeted by the AEC under the physical research program. The costs incurred by the AEC in fiscal year 1959 and fiscal year 1960 for this activity are excluded, for purposes of comparability, from the physical research program costs in this presentation.)

The increase of $19,856,000 in fiscal year 1961 over the level of $143,344,000 estimated for fiscal year 1960 is primarily associated with the increased costs of the high energy physics program. The portion of the physical research program devoted to high energy physics is indicated in the following tabulation.

[In thousands]

Item	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961	Increase or decrease fiscal year 1961 compared with fiscal year 1960
High energy physics research	$20,918	$26,877	$34,800	+$7,923
Design and development of high energy accelerators and experimental apparatus	4,168	7,257	7,951	+694
Equipment associated with high energy physics	2,441	5,685	9,133	+3,448
Total costs associated with high energy physics	27,527	39,819	51,884	+12,065
All other physical research program costs	87,119	103,525	111,316	+7,791
Total physical research program	114,646	143,344	163,200	+19,856

Summary of estimates by category

Category	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
1. High energy physics	$20,918,254	$26,877,000	$34,800,000
2. Nuclear structure and neutron physics	13,189,764	14,711,000	16,221,000
3. Extra-nuclear properties of matter	815,363	795,000	941,000
4. Design and development of devices for physics research	5,058,379	8,989,000	9,518,000
5. Physical methods of isotope separation	1,082,050	1,295,000	1,595,000
6. Computer development and mathematics research	1,989,570	3,140,000	3,842,000
7. Process chemistry	4,675,583	5,374,000	6,050,000
8. Chemical properties and reactions	16,963,749	19,700,000	23,242,000
9. Chemical isotope separation studies	583,644	1,020,000	960,000
10. Special projects	1,716,233	2,331,000	2,400,000
11. Preparation and purification of special research materials	258,950	875,000	1,248,000
12. Production, treatment, and properties of materials	2,400,851	2,818,000	3,675,000
13. Alloy theory and the nature of solids	4,811,009	6,093,000	7,682,000
14. Effects of irradiations on materials	1,887,705	2,930,000	3,543,000
15. Controlled thermonuclear research	26,972,447	32,251,000	29,300,000
16. Equipment not included in construction	11,322,334	14,145,000	18,183,000
Total physical research program	114,645,885	143,344,000	163,200,000

JUSTIFICATION OF CATEGORIES

1. High-energy physics, $34,800,000

High-energy physics continues to be one of the most active fields in contemporary science. Research in this field is primarily aimed at a fundamental understanding of the properties of the particles of which all matter is formed. Extensive progress has already been made, and there is excellent promise of a rapid expansion of our knowledge of the properties of these particles in the future. In the initial phase of these studies, major emphasis was placed on the identification of the various elementary particles which are produced by multi-billion electron-volts accelerators. Certain of their properties were measured; these included their masses, lifetimes, and decay products. At present, however, with much of this information now known, the emphasis is on determining other properties, such as their magnetic moments, which are considerably more difficult to measure, and which, consequently, require much more complicated setups of equipment and personnel. Many early experiments consisted of inserting a small amount of photographic emulsion in the beam of an accelerator.

Present experiments require elaborate apparatus, such as chains of bending and focusing magnets, in order to provide as intense and monoenergetic a beam of particles as possible, complicated beam separators for removing unwanted particles from the beam, and, finally some detecting device, such as a large liquid hydrogen bubble chamber.

Funds in this category support the operation of various high-energy accelerators, in addition to supporting the basic research itself. These accelerators include the bevetron at Lawrence Radiation Laboratory (a 6-Bev. proton synchrotron), the cosmotron at Brookhaven National Laboratry, and several electron synchrotrons and proton synchrocyclotrons of lesser energies. In addition to these machines, three new ones are scheduled for initial operation in fiscal year 1961. These are the 30-Bev. alternating gradient proton synchrotron (AGS) at Brookhaven National Laboratory, the 6-Bev. Cambridge electron accelerator (CEA), and the 3-Bev. Princeton-Pennsylvania high-intensity proton accelerator (PPA). A 12.5-Bev. proton synchrotron (ZGS) is under construction at Argonne National Laboratory. Provision for the initial one-shift operation of the three new machines, as well as for the associated research, will require an increase of $4,132,000 in fiscal year 1961. In addition, more effective utilization of the Bevetron, 184 Cyclotron, and Cosmotron and associated experimental facilities requires an increase of $2,580,000.

As the simpler experiments are performed, coninued advances depend on carrying out increasingly difficult measurements. As an example, an initial study of the interaction of K mesons with protons in a bubble chamber required a study of 100 events. A second study required 1,000, and a current one 10,000. As a result of the vast amount of data which must be handled, increasing use of automatic apparatus is foreseen, including extensive use of automatic computers for analysis. In addition, older techniques, such as counters of various types,

will be refined for higher precision, and new ones will play an increasingly important role. In the latter category the use of filamentary scintillation chambers presently shows the most promise. The use of this equipment will increase the scientific output in high-energy physics, but it will also increase the cost of doing research. To provide for these developments and the above-described operation and research associated with the accelerators, a total increase of $7,923,000 is required in this category.

2. Nuclear structure and neutron physics, $16,221,000

This category includes research relating to low-energy nuclear processes with many of the results being vital to Commission programs in reactor development and weapons. The work includes major programs at Argonne National Laboratory, Brookhaven National Laboratory, and Oak Ridge National Laboratory, in which experimental and theoretical studies are directed at providing a better understanding of the nucleus.

In some cases, studies such as those of beta-ray spectroscopy and scintillation spectrometry are performed, using radioactive sources and reasonably modest analyzing and detecting equipment. In other cases, such as for studies of neutron cross-section measurements, more elaborate facilities, including reactors and accelerators, are required merely as the means of producing the neutrons.

While the cross-section measurements program includes that of charged particles as well as neutrons, particular attention is given to the neutron interactions. To cover the necessary neutron energy range from thermal to millions of electron volts, various arrangements of reactors and accelerators with particular analyzing and detecting equipment are required. Thus, some programs use crystal spectrometers, others use choppers, and still others use time-of-flight detection. Recognizing programmatic needs, the fissile nuclei and reactor moderator, coolant, and structural materials receive special attention.

Beside the programs at the national laboratories, approximately 50 universities are engaged in this research. The studies at the universities range from those using modest equipment in nuclear decay studies at the University of Oregon to those using a Tandem Van de Graaff at Wisconsin for studying proton-proton scattering, coulomb excitation, neutron interactions, and other subjects. Many of the university programs center around a particular major piece of equipment, such as a Van de Graaff, cyclotron, Cockcroft-Walton, etc.

An increase of $1,510,000 is required for this activity. The increase will permit the strengthening of the theoretical group, the instrument development group, and Van de Graaff group at ORNL. At ANL some increased funds are required for bolstering the temporary appointment program. Here distinguished senior scientists and exceptionally promising younger scientists can participate in laboratory programs with mutual benefit. Also, an increase is required to make full and effective use of the presently operating accelerators as well as those scheduled to achieve full-scale operation by fiscal year 1961. The latter include the 30 Mev. variable energy cyclotron at Colorado, the new high current Electron Linac at Yale, the Tandem Van de Graaff at Wisconsin, the 5.5 Mev. Van de Graaff at Pennsylvania State and the 32 Mev. Proton Linac at Southern California. Increased funds are also needed for expansion of the neutron cross section measurements program. Here certain neutron cross section measurements needed by reactor and shielding designers, which have previously not been accessible to measurement or only measureable with considerably less than the desired accuracy, can now be performed due to new techniques being developed on time-of-flight systems for Van de Graaffs.

3. Extranuclear properties of matter, $941,000

This activity includes such studies as optical spectroscopy, mass spectrometry, behavior of low energy ions in matter, magnetic resonance techniques, and low temperature phenomena. Research studies on extranuclear properties of matter at Oak Ridge National Laboratory, Argonne National Laboratory, and six universities are supported under this activity.

The work is directed toward improving the various methods of study and then applying the methods to a number of fundamental problems.

The research effort in this activity will be maintained at the current level. The increase in funds of $146,000 results primarily from the costs associated with the MTR and ETR irradiations.

4. Design and development of devices for physics research, $9,518,000

Progress in nuclear physics research, especially that in the higher energies, is dependent on the availability of good research tools. The tools used for nuclear physics research include not only the particle accelerators and research reactors, but also the extremely complex detecting devices and analyzing equipment. Support of this program is continued in order to assure (1) that adequate tools will be available to physicists in future years as the frontiers move forward; and (2) that existing facilities, or those under construction, can continue to be improved for optimum research use. Phases of this program are conducted at Argonne National Laboratory, Oak Ridge National Laboratory, Brookhaven National Laboratory, Lawrence Radiation Laboratory, Midwestern Universities Research Association, and several universities, including Stanford.

The increase ($529,000) is needed for the development of experimental apparatus to be used with the new high energy accelerators now under construction, three of which will come into operation in fiscal year 1961.

5. Physical methods of isotope separation, $1,595,000

The narrative for this category is contained on classified page 169.

6. Computer development and mathematics research, $3,842,000

The complexity of the Commission's programs has led to considerable dependence on the use of high speed automatic computers in many phases of its activities. Numerical computations are of growing importance in nuclear research: the design of accelerators, reactors and weapons; production scheduling; operations analysis; meteorological and many other applied activities. This category provides research support behind the computing services at the national laboratories, the operation of the computing center at New York University, the development of advanced computers at the University of Illinois, Rice Institute, and the University of Chicago, and studies of improved computer components at Duke University and General Electric Co. These several elements of the program are identified in the activities listed as follows:

(*a*) Computer research and development:

Fiscal year 1959	$997,570
Fiscal year 1960	1,295,000
Fiscal year 1961	1,664,000

This activity includes the cost associated with research leading to better computers and data processors by means of improvements of components, logical design, circuit design, switching theory and system analysis. Three computers will be tested in fiscal year 1960 and peripheral apparatus will be developed in fiscal year 1961 to complete the computer complexes. LRL will continue work on a special purpose computer to analyze photographs of nuclear events.

(*b*) Computer usage:

Fiscal year 1959	$360,000
Fiscal year 1960	763,000
Fiscal year 1961	875,000

This activity includes costs for carrying out the numerical analysis, programing, coding, and actual running of the mathematical problems associated with other parts of the physics program. Some additional time for research contractors will be made available on the MURA and NBS computers.

(*c*) Mathematics and programing research:

Fiscal year 1959	$632,000
Fiscal year 1960	1,082,000
Fiscal year 1961	1,303,000

This activity includes costs associated with mathematics and programing theory, including computer time directly associated with this research. One or two mathematicians will be added to BNL staff to assist the users of the machine, which is coming into operation. Most of the costs in this category arise from the support of the applied mathematics work at New York University.

7. Process chemistry, $6,950,000

This activity includes the acquisition of data pertinent to the development of chemical processes of interest to the Commission as well as basic chemical engineering and unit operations studies. In view of the many technical problems associated with the Commission's programs in chemical processing, reactor

chemistry, production, and weapons development, long range applied and fundamental process research programs are necessary. Such a research effort is required to solve current problems and to anticipate and obviate future problems. New methods for processing various types of nuclear fuels must be studied, new separation procedures must be investigated, new chemical engineering unit operations must be understood and their application in equipment and plant design studied and evaluated. The solution of the serious high-temperature materials problems, so essential to the success of many reactor concepts, is partially dependent on research of the type carried out under this activity. These programs provide the necessary link between the basic chemistry research activities and the highly specialized development projects.

Examples of the research programs carried out under this activity are evaluation of ideas for new separations processes on a preliminary laboratory basis, volatility studies, ion exchange studies, solvent extraction research, geochemical research, the chemistry of inorganic systems at high temperature, fundamental physical-chemical studies pertinent to fuel and processing systems, metal dissolution studies, equipment decontamination studies, chemical engineering research studies, and development of analytical methods for use in the new and unusual processing and fuel systems.

An increase of $676,000 is required for this activity in fiscal year 1961. An increase of $100,000 is needed for a program on the continuous reduction of uranium oxides by solutions of magnesium or calcium in mercury. The use of amalgams as mass and heat transfer media for reduction of metal oxides and separation of metals indicates the possibility of the development of a continuous, easily controllable process at a low temperature. An increase of $400,000 is required for an expansion of high-temperature process studies, including high-temperature materials applications, high-temperature separations, and thermochemical research. The remainder of the expansion will support research in new chemical engineering and unit operations techniques and acquisition of background chemical information applicable to the development of separation methods.

8. Chemical properties and reactions, $23,242,000

This activity includes the basic chemical research which is so important to the success of the applied research and development programs of the Commission. This work serves as the basis for the chemical and chemical engineering activities underlying all aspects of atomic energy technology. The new chemical concepts and theories, new techniques, and the improved understanding of chemical systems and materials resulting from this research contribute to a sound foundation for future practical applications and developments. This program is very broad in its coverage and its content is described in the following paragraphs.

Nuclear chemistry studies involve the formation, isolation, identification, and study of the nuclear properties and reactions of radioactive nuclides. Techniques of modern nuclear science, such as reaction of nuclides with high-energy-charged particles, neutron reactions, fission studies, and alpha-, beta-, and gamma-ray spectroscopy, lead to information which is applied to assist in the understanding of the nucleus and nuclear forces, and for the development of nuclear theory. The study of the nuclides of the heavy elements is an important part of this work. Both the naturally occurring nuclides in this part of the periodic system (all radioactive) and those produced by nuclear reactions in the laboratory are studied. The production of very heavy nuclides is accomplished either by bombardment with high-energy heavy ions, e.g., C^{12}, N^{14}, O^{16}, and Ne^{20}, or by the successive capture of several neutrons in reactors at very high neutron fluxes. To produce the heaviest nuclides it is planned to bombard such isotopes as C^{252}, itself produced from plutonium by the capture of several neutrons, with heavy charged ions. Research in heavy-element nuclear chemistry also includes such subjects as the fission process under various conditions, decay schemes, and energy levels of excited nuclei. Other areas of interest are the nuclides resulting from fission, nuclear reactions produced by very high energy particles (spallation), and angular correlation in multiple decays which take place in coincidence. Examples of additional problems under study in this field are: angular distribution of the fragments of fission induced by charged particles, spontaneous fission processes, the neutron cross sections of transuranic nuclides (important to reactor design and operation), coulomb excitation by highly charged energetic heavy ions, and the nuclear anisotropy and angular correlations which are observed by low-temperature nuclear alinement.

Radiochemistry, which can be defined as the application of radioactive nuclides to the problems of chemistry, is closely related to nuclear chemistry. Radioactive isostopes are used to study exchange reactions of atoms as well as electron transfer reactions, the determination of reaction mechanisms by following the course of radioactive tracers through a reaction, and the identification and origin of materials by the presence of very small amounts of radioactive species, e.g., meteorites and tektites. Two important aspects of radiochemistry are the development of isolation and counting techniques, and the behavior of essentially carrier-free radioisotopes. The latter is important since at very small concentrations a substance may not behave as it does at higher concentrations.

Radiation chemistry is concerned with the study and interpretation of the chemical effects and reactions resulting when energetic radiation interacts with matter. Such interactions may produce deleterious effects on substances as well as new, interesting, and useful chemical changes. Fundamental research in this field has as its goal the understanding of the chemical reactions that take place, how they occur, and the various factors which affect these reactions. Some of the factors which are of significance and are currently being studied include: the effect of physical state, the effect of temperature, the differences between the effects produced by heavy particles and electrons or electromagnetic radiations, the effects of added materials, the transfer of energy from one species to another, the effect of dose rate, and the relative importance of excited atoms or molecules, ions, and radicals in the chemical transformations taking place. Examples of specific subjects being studied are: the decomposition of methane dissolved in water, the radiolysis of ammonia to form hydrazine, the radiation-induced oxidation of simple organic compounds, radiation effects on a gaseous system, the radiation decomposition of benzene, the radiolysis of mixtures of benzene and cyclohexane, the radiation decomposition of ethane in liquid and gas phase, and radiation-induced changes in catalytic activity. Closely related to radiation chemistry is the field called hot-atom chemistry which is concerned with the fate of energetic atoms produced as the result of nuclear transformation.

General physical and inorganic chemistry includes the investigation of chemical reactions and properties which will lead to a better understanding of the chemical activities related to the Commission's program. Thermodynamic and kinetic data are obtained, in order to assist in predicting those reactions which will take place, and the mechanisms which are involved. Aqueous chemistry of such elements as the actinides (including thorium, uranium, neptunium, plutonium, and the transplutonium elements), as well as the lanthinide elements, is under investigation. The formation of complex ions and their properties are being studied. Other subjects being investigated include: the volatile fluorides of the heavy elements, the thermodynamics and structure of interhalogen compounds, the use of mass spectrometers for electron impact studies and ionization potential measurements, and the behavior of ion-exchange materials and their application to chemical problems. New techniques, such as nuclear magnetic resonance, electron spin resonance, neutron diffraction, and many others are being applied.

High-temperature and materials chemistry is considered separately from general physical and inorganic chemistry, because of its importance to the solution of many AEC problems and because of the unique nature of the techniques applied. There is a paucity of information on the chemical behavior of materials at high temperature and efforts are being made to build up an adequate background of information in this field. Reactions are being observed at high temperature, and new substances prepared and characterized. Thermodynamic and kinetic information is being gathered for many reactions and substances, as well as structural information on solids by X-ray and neutron diffraction methods. Substances such as carbides, borides, nitrides, and sulfides are becoming increasingly important along with the more common oxides and metals and their preparation, chemical stabilities, and physical properties are being determined. The use of high-temperature mass spectrometry techniques are particularly valuable for the work on vapor pressure and decomposition. Two other fields of high-temperature research are those of molten-salt systems and aqueous systems at elevated temperatures and pressures. The former include such studies as the structure of molten electrolyte, chemical reactions in molten-salt media, the behavior of metals in molten salts, the formation of complex ions in fused salts, the electrochemistry of such systems, and the mechanism

of electrical conduction in fused ionic media. The behavior of aqueous solutions at high temperatures and pressures is often quite different from that at ordinary temperatures. Studies in electrochemistry, surface absorption, and surface reactions have as their goal an understanding of the surface phenomena important to the solution of corrosion problems.

Analytical chemistry research is necessary to meet requirements for analysis that occur in the Commission programs. Such needs include refined analytical techniques to determine the very small amounts of impurities in pure substances required for research and development, the need for adequate methods for determining small amounts of oxygen and nitrogen in metals, and the analysis of very radioactive materials. Some of the methods under investigation are spectroscopy, polarography, and other types of instrumental analysis, as well as the neutron activation and isotope dilution techniques. Organic chemistry research is devoted largely to those types of compounds which are used in Commission programs, and to the application of nuclear techniques to the solution of problems which lead to a better understanding of the mechanisms of organic reactions. Organic tracer studies and isotope effects studies are related to radiochemistry and chemical isotope separation studies, respectively.

An increase of $3,542,000 is requested for this activity, with the major portion in the following fields: nuclear chemistry research, particularly in the nuclear properties of the transplutonium elements and in those areas made possible with the startup at the AGS at BNL and other new accelerators ($1,250,000); effects of radiation on chemical systems ($500,000); fundamental studies of the behavior and properties of chemical systems at high temperatures ($1,100,000); and analytical research, with emphasis on the analysis of materials for very low concentration impurities and of highly radioactive materials ($200,000). The remaining increase ($492,000) is required to strengthen the physical and inorganic chemistry program related to Commission interests, with emphasis on research related to the fundamental aspects of corrosion, research on the aqueous and nonaqueous chemistry of the actinide elements, and studies of the thermodynamic and kinetic properties of chemical systems.

9. Chemical isotope separation studies, $960,000

The Atomic Energy Commission maintains a continuing interest in the development of more efficient and more economical methods for the enrichment and the separation of a wide variety of isotopes of importance to the Commission's program. Basic and applied research in chemical methods of isotope separation is carried out at the National Laboratories as well as at several universities. Supplementing these separation studies is a program of research on the thermodynamic, kinetic, spectroscopic, and chemical properties of isotopically substituted compounds.

Isotopes of especial interest and importance at this time are those of oxygen, carbon, calcium, sulfur, and plutonium. To better understand the isotopic fractionation processes involved in each of these systems, investigations of the following types are required: nature and extent of the bonding of the isotopic species involved; solubility and distribution of the element in the system; the rate of exchange of the isotopic species; the magnitude of the isotopic fractionation factor; methods of efficiency of refluxing each species; effects of impurities; and the economic and competitive status of the process. New concepts in isotope separation are being developed; examples are the use of nonaqueous media in solvent extraction systems, low-temperature selective adsorption techniques, and the combining of complex formation with ion exchange. A cascade suitable for the enrichment of research amounts of high-purity oxygen 18 and intermediate purity oxygen 17 is currently being assembled and will be in operation in fiscal year 1961.

The research effort for the development of new concepts in isotope separation will require an increase of $40,000 in fiscal year 1961. This amount, however, is offset by a decrease of $100,000 occasioned by a nonrecurring cost in fiscal year 1960 for the oxygen isotope cascade, resulting in a net decrease in fiscal year 1961 of $60,000 for this activity.

10. Special projects, $2,400,000

The narrative for this category is contained on classified pages 169 and 170.

11. Preparation and purification of special research materials, $1,248,000

This activity includes costs of programs for the manufacture, recovery, purification, separation, and concentration of radioactive isotopes and other special

materials for research applications in chemistry, physics, and metallurgy. Processes will be investigated, developed, and improved for obtaining research quantities of new, unusual, or significant radioactive isotopes, stable isotopes, and transuranium elements and their isotopes. New nuclides will be obtained by irradiating enriched stable isotope samples in both thermal and fast neutron regions of nuclear reactors and by bombardment in cyclotrons and other accelerators. Processes will be developed for recovering transuranium elements, especially americium, curium, and californium. Processes for rare earth removal from Am-Cm fractions of highly irradiated Pu will be tested. Process streams, residues, and other special nuclear material production channels and storage areas will be examined for locations and concentrations of trace elements (neptunium, technetium, and protactinium, for example) which are of special interest to atomic energy research and development programs. The effort to obtain californium 252 will include costs of target fabrication, reactor irradiations, chemical separations, reirradiation of separated products.

An increase of $373,000 is required for fiscal year 1961 to cover costs of handling and processing the products of the first large-scale plutonium irradiations in the program to produce californium 252 and other important transplutonium elements, and for chemical research and development for processes required for this program.

12. Production, treatment, and properties of materials, $3,675,000

Semifundamental or applied research is supported under this category with the objective to learn as much as possible about materials of known or possible usefulness in atomic energy. This work is concerned with investigations characterized by the uses or properties of materials and by processes for production and treatment of materials.

Study is concentrated on problems associated with the use of uranium, plutonium, and thorium as fissionable or fertile materials and includes such topics as the development of new methods for extracting or purifying these metals, investigations of new alloys, their heat treatment and properties. Similar studies are also in progress for nonfissionable materials, particularly those of interest as a moderator, shield, control, or cladding.

Another important aspect of this category is the study of surface reactions and the development of corrosion-resistant alloys, devoting particular attention to the media of liquid metals, fused salts, and high-temperature water. Also supported under this category is research on the preparation of research quantities of pure materials for use in fundamental investigations.

The increase of $857,000 planned for fiscal year 1961 provides for increased efforts on characterization of research materials ($330,000), plutonium metallurgy ($300,000), applied corrosion studies ($157,000), and research on oxides and slurries ($70,000).

13. Alloy theory and the nature of solids, $7,682,000

The aim of this program of fundamental studies is to obtain increased understanding of the nature and behavior of materials. Emphasizing the study of phenomena as compared with the study of specific materials in the previous category, these basic investigations provide a foundation of knowledge for future utilization and are a prerequisite for the fundamental understanding of the influence of radiation on materials. Examples of individual researches include alloy theory; electronic structure of solids; mechanisms of atom movements in solids and liquids; the thermodynamics and kinetics of reactions; the origin and influence of lattice imperfections in solids; X-ray and neutron diffraction structural studies of liquid and solids; the nature of the strain hardened state; the mechanisms of recovery, recrystallization, and grain growth in materials, and the physics of surface reactions.

The increase of $1,589,000 requested for fiscal year 1961 provides for an increased effort in fundamental physical metallurgy ($333,000), physical ceramics ($300,000), and solid state physics research ($956,000).

14. Effects of irradiations on materials, $3,543,000

The effects of radiation and of energetic particulate matter on the properties of materials is an ever present problem in the program of exploitation of atomic energy. This category is for the support of research directed toward understanding the mechanisms operative in the interaction of radiation and matter. Some of the parameters under study are (1) the type of radiation, (2) its energy, (3) its intensity, (4) the crystallographic structure of the solid, (5) the

type of binding in the solid, (6) the temperature of irradiation, (7) history of the sample prior to irradiation, (8) the history of the sample subsequent to irradiation, and (9) the chronology of the measurement relative to time of irradiation.

Studies include effects of radiation on the physical, electrical, and mechanical properties and the effects of radiation on solid state reactions.

An increase of $613,000 is requested for new and increased fundamental studies of the effects of radiation on graphite, alloys and thermoelectric materials; effects of fission recoils, energetic particulate matter, and general radiation on surface properties; and the factors influencing fission gas swelling.

15. Controlled thermonuclear research, $29,300,000

Research and development leading to the controlled production of power from the fusion of heavy hydrogen nuclei is being conducted at four major laboratories: Los Alamos Scientific Laboratory (LASL), Oak Ridge National Laboratory (ORNL), Princeton University's Forrestal Research Center, and the Lawrence Radiation Laboratory at Berkeley and Livermore, Calif. (LRL). Supporting work on specialized aspects of the program is carried on at New York University, the Naval Research Laboratory, and a number of universities and industrial organization.

The controlled production of power from nuclear fusion requires that deuterium gas be heated to a temperature of the order of 400 million degrees centigrade, or that a deuterium-tritium mixture be heated to a temperature of 50 million degrees. Furthermore, the ionized gas (plasma) must be confined long enough to permit an appreciable fraction of the fusionable nuclei to collide and liberate nuclear energy. In all cases under active investigation, magnetic fields are used to confine the plasma.

In attempting to create or establish the very hot plasma, a number of different methods show promise. Similarly there are several types of magnetic field configurations which can be employed. Consequently, the Commission's program is fairly broad and consists of several basic approaches to the problem.

The work of the past year led to the following notable advances:

1. Increase in the ability to measure plasma conditions.

2. Clear understanding that if stable thermonuclear plasmas can be obtained in steady state mirror machines, power-producing devices with outputs as low as about 20 megawatts could be made to operate, by the use of strongly cooled magnet coils of sodium or aluminum. Previously, it was thought that fusion reactors with outputs lower than 1,000 megawatts might never be possible.

3. Production of well-randomized neutron-producing plasmas with particle energies superior to 1 kilovolt (or 10 million degrees). This was done at LASL in a machine called SCYLLA, and at the Naval Research Laboratory. It is a question of definition whether we would call these plasmas thermonuclear; the important point is that with somewhat improved equipment, further advance toward the critical temperature can and will be made.

4. Ions can now be injected into transient mirrors at Livermore at energies of 500 volts or better, compared with a figure of 50 volts a year ago.

5. At ORNL, the output of ion sources for high energy injection has been greatly improved. Large hollow arcs have been demonstrated as a means for keeping slow molecules out of the magnetic bottle.

6. At Princeton, the method called ion-cyclotron-resonance heating has been greatly developed. By this method, radiofrequency power has been introduced into a plasma with an efficiency greater than 75 percent. The model C stellarator schedule has been revised, looking toward completion about March 1961 rather than September 1960.

The general research and development effort and major approaches follow:

General research and development:

Fiscal year 1959	$3,317,171
Fiscal year 1960	3,456,000
Fiscal year 1961	2,930,000

This activity provides for the general research and development effort in support of the overall controlled thermonuclear program. Included are the theoretical and computation programs and basic plasma physics research at Lawrence Radiation Laboratory and Princeton as well as the contract research program carried out at educational institutions, industrial laboratories, and nonprofit research institutes. This work includes general theoretical studies, experi-

ments on shock waves, development of diagnostic tools and techniques, ultra-high vacuum techniques, study of materials attacked by soft X-rays, plasma oscillation, extreme ultraviolet techniques, and plasma turbulence.

The net decrease of $526,000 in this activity comes mainly from two factors: (1) cessation of high-energy injection at LRL, and (2) a slight increase for small-scale fundamental research programs primarily at university laboratories on problems which they are particularly well-equipped to handle. (Increased support of this type of research would be in accord with a strong recommendation of the Sherwood steering committee to bring into the Sherwood program some scientists whose skills would not otherwise be available to the controlled thermonuclear research program.)

Stellarator approach

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
Total	$11,645,170	$14,435,000	$11,470,000
C stellarator—Fabrication	8,469,791	10,397,000	6,550,000
C stellarator—Operation and modification	0	460,000	1,680,000
Stellarator—Research and development	3,175,379	3,578,000	3,240,000

The Stellarator approach is based on the containment of plasma in a strong longitudinal magnetic field produced in an endless tube by means of current-carrying coils surrounding it. A relatively complex coil configuration is required to produce stability and counteract adverse effects of the tube curvature. Initial heating is accomplished by comparatively weak currents passed through the plasma; further heating results from the application of strong radiofrequency magnetic fields.

The net decrease of $2,965,000 is due almost entirely to the drop in costs associated with the design, engineering, fabrication, installation, and testing of the model C Stellarator. Subsequent research operation of the machine will require an increase of $1,220,000 in fiscal year 1961. Operation of model C on a limited basis, primarily for confining-field coil tests and electron-gun checks of the complex magnetic field configuration, is expected to begin in mid-fiscal year 1961 and continue for about 3 months. Essentially, full operation of the facility for first-stage experimentation using ohmic heating will begin in late fiscal year 1961 and continue, for about a year. Delivery of second-stage components, principally ringing-circuit magnetic pumping equipment and divertor, is expected to be complete by the end of fiscal year 1961.

During the same period research with B-scale devices shows a $338,000 decrease in fiscal year 1961, reflecting the gradual shift in emphasis to research using model C.

Magnetic mirror approach:

Fiscal year 1959	$2,504,385
Fiscal year 1960	2,930,000
Fiscal year 1961	3,600,000

Here the plasma is contained in a strong externally applied longitudinal magnetic field; strong coils at either end of a cylindrical chamber establish the magnetic mirrors which reflect the electrically charged plasma particles back into the central region of the magnetic bottle. The general method of heating is to compress the plasma by increasing the magnetic field strength. All of the effort under this activity is accomplished at the Livermore site of Lawrence Radiation Laboratory. There have been continuous improvements in the capabilities of the mirror machines, particularly Toy Top, a multiple compression device which has yielded particle energies approaching the thermonuclear range. The increase of $670,000 will be directed toward the development of suitable cryogenic coils, neutral injection, and intensified effort on two existing mirror machines.

DCX approach:

Fiscal year 1959	$3,980,164
Fiscal year 1960	5,570,000
Fiscal year 1961	5,400,000

This approach carried out at Oak Ridge National Laboratory involves the injection of very energetic molecular ions into a DC magnetic mirror configuration. Breakup of these ions by a high-current vacuum arc results in the trapping of "hot" atomic ions. The problem is then one of containing these ions long enough for the ion density to build up. Energetic injection is a method of heating which is probably not confined to mirror geometeries. The DCX–1 machine is nearing the end of its useful life. Design of its successor, DCX–2, has been retarded by the necessity of considering information obtainable only from DCX–1. Fabrication of the successor my begin in fiscal year 1960, but most of the costs will be concentrated in fiscal year 1961. The program is expected to remain relatively stable with the changeover.

Relativistic electron approach:	
Fiscal year 1959	$886,287
Fiscal year 1960	610,000
Fiscal year 1961	1,000,000

This approach carried out at Livermore site, Lawrence Radiation Laboratory, consists of heating and containing plasma by means of a cylindrical layer of spiraling relativistic electrons established inside a solenoidal field. Results on the Astron device have been encouraging. An electron current of 50 amperes has been injected into a mirror, and a novel method for trapping electrons has been devised. The program requires larger equipment and larger expenditure rate during fiscal year 1961; it is being built in logical successive stages, tested in sequence.

Pinch, magnetic-shock compression, and rotating plasma approach:	
Fiscal year 1959	$4,639,270
Fiscal year 1960	5,250,000
Fiscal year 1961	4,900,000

In the shock-compression and pinch approaches, strong electric currents produced within the plasma itself generate strong magnetic fields which compress and confine the plasma. High-current discharges established in either linear or toroidal tubes compress the plasma. Compression by the magnetic field heats the gas and raises its density. The original pinch devices have been replaced by much more sophisticated apparatus which has yielded plasma stable for increased periods of time. In the rotating-plasma approach, the hot gas is set into rotation by means of a radial electric field and a longitudinal magnetic field. Heating is by conversion of rotational kinetic energy into internal energy of the plasma. Devices now under investigation are the homopolar device and ion magnetron at the Lawrence Radiation Laboratory, and the Ixion at Los Alamos Scientific Laboratory.

At Los Alamos, work on the fast pinch devices of the Columbus and Perhapsatron classes is being sharply reduced to permit greater effort on Scylla, Ixion, and plasma-projection machines. Fabrication of a second model of the Ixion (rotating plasma) machine is still under consideration. A large condenser bank (Zeus) is approaching completion. Installation of condensers in this facility is programed at minimum levels in accordance with actual needs. The balance of the work under this activity is the very successful magnetic-comparison research carried on at the Naval Research Laboratory.

16. Equipment not included in construction projects, $18,183,000

Equipment requirements for the physical research program are estimated at $18,183,000 for fiscal year 1961, representing an increase of $4,038,000 over fiscal year 1960. Equipment associated with the high energy program in fiscal year 1961 is estimated at $9,133,000, or $3,448,000 more than the $5,685,000 estimated for fiscal year 1960. The total equipment estimate is based on normal requirements as indicated by past experience and on the needs of the research program planned for fiscal year 1961. The major portion of the equipment provided under this category will support the research programs at the Commission's major research centers. The remainder will support research conducted under the contract research program principally at educational institutions.

The equipment to be purchased includes replacement as well as equipment additions necessary to support the program. Major equipment additions are detailed as follows:

(1) High energy physics equipment for the alternating gradient synchrotron and the cosmotron at Brookhaven National Laboratory, including components

for the 80-inch bubble chamber, shielding, beam magnets, power supplies, and vacuum piping, $3,600,000.

(2) High energy physics equipment for the Lawrence Radiation Laboratory bevatron and 184-inch cyclotron, including analyzing magnets, a precision hyrogen bubble chamber, and advanced data analysis equipment, $1,300,000.

(3) Components for the bubble chamber and other equipment to be used in the high energy physics research programs at Argonne National Laboratory utilizing the zero gradient synchrotron now under construction, $1,650,000.

(4) Quadrupole and deflector magnets, motor generator sets, power supplies, and liquid hydrogen bubble chamber equipment necessary for the high energy physics research programs at the Princeton-Pennsylvania and Cambridge accelerators, $2,033,000.

(5) Equipment requirements for the high energy physics programs at MURA and at the Nation's educational institutions, $550,000.

(6) Heavy water system for the Oak Ridge research reactor, $430,000.

There follows a breakdown of the total equipment costs for fiscal year 1961, indicating amounts estimated for each installation in relation to its operating costs under this program:

[In thousands]

Installation	Other operating costs	Equipment costs
Brookhaven National Laboratory	$17,050	$5,000
Argonne National Laboratory	15,740	2,555
Oak Ridge National Laboratory	20,117	3,330
Lawrence Radiation Laboratory	26,475	2,000
Contract research program	36,693	2,068
Princeton-Penn accelerator	1,300	1,150
Cambridge accelerator	1,790	883
Princeton (CTR)	12,100	546
Ames Laboratory	3,523	250
Los Alamos Scientific Laboratory	3,200	140
Midwestern Universities Research Association	2,200	100
Knolls Atomic Power Laboratory	465	70
New York University	1,615	60
Atomics International	688	30
Sylvania Electric Products	60	1
Stanford	800	0
Hanford	745	0
Phillips Petroleum	420	0
Battelle Memorial Institute	36	0
Total	145,017	18,183

Mr. CANNON. I would like to ask at this point what particular notable achievement has been made in the research programs in the last year.

ACHIEVEMENTS OF THE LAST YEAR

Dr. MCDANIEL. The achievements made under the research program of last year are numerous. I think it would be not correct to lay my finger on one item and cite that one as being the achievement of the year. Certainly the scientists who have been working under the program have each as individuals developed a better understanding in their own particular field, and have published thousands, perhaps scores of thousands, of individual documents listing the fundamental laws which they have further elucidated. So as far as any one particular thing is concerned, I don't think I should lay my finger on any one particular item.

Mr. CANNON. Will you review the principal activity increases that make up the total increase of $19,856,000 allotted to this work?

INCREASES IN ESTIMATES

Dr. McDANIEL. Yes, sir. Of the $19,856,000, $12.1 million of it is due to the high energy physics program and the remainder of $7.8 million is what results from increases and decreases in the chemistry and metallurgy program.

In the high-energy physics program, as you know, the Argonne zero gradient synchrotron will be finished in June 1962. It will be necessary to procure equipment and to bear the present operational cost for that machine and it will cost about $2.3 million.

At the Brookhaven National Laboratory, as you know, the alternating gradient synchrotron will be finished within the next few weeks, or at worst within the next 2 or 3 months. The preoperational cost of that and the cost of equipment for use with the machine will be $4.6 million.

The Cambridge electron accelerator, an accelerator being constructed on the Harvard campus jointly by Harvard University and the Massachusetts Institute of Technology, will be completed next year, and will require about $1.5 million increase for preoperational and equipment costs.

The Princeton-Pennsylvania accelerator being built on the Princeton University campus will be finished by this time next year, and will require $1.2 million of preoperational and equipment cost.

So the total cost for equipping the machines which will be finished in the next year is $9.6 million. In addition, the increased utilization of existing accelerators—the cosmotron at the Brookhaven National Laboratory, and the bevatron and 184-inch cyclotron at Lawrence Radiation Laboratory, discussed yesterday—will require an additional $2 million. All other research in high-energy physics including the research in the universities, the high energy-physics research that goes on at Oak Ridge, and the increases and decreases at the Stanford University and Midwestern Universities Research Association make up the balance of $2.5 million—or a total increase of 12.1 million in this field.

As for the remaining $7.8 million, mathematics research will require $2.5 million; chemistry research, $4.6 million; and metallurgy research $3.1 million. There is a decrease of $3 million in the controlled thermonuclear research program, and an increase for equipment other than high-energy physics of $0.6 million.

The sum total of these increases is $19.9 million, which the Chairman discussed.

DELAY IN PRINCETON MODEL C STELLARATOR

Mr. CANNON. Just chosing one at random, the work at Princeton University has been greatly delayed. They were supposed to have completed by this time. What is the difficulty there?

Dr. McDANIEL. The Princeton Model C Stellarator was due to have been finished within the next fiscal year. Indeed, it will be essentially completed within the next fiscal year. However, the culmination of some strikes and other delays has resulted——

Mr. CANNON. Over which they had no control.

Dr. McDaniel. Over which Princeton University had no control, has resulted in the delay of receipt of equipment which needs to be installed. The project will be completed within the original estimated cost of $26 million. There has been no overrun in this project. Princeton University will be able to begin their research with the machine soon, within the next few months; certainly within the next year.

Mr. Cannon. There has been no avoidable delay?

Dr. McDaniel. No.

Mr. Cannon. What has been achieved in controlled thermonuclear research?

CONTROLLED THERMONUCLEAR RESEARCH

Dr. McDaniel. During the last year considerable advances have been made in the controlled thermonuclear research program. The increase in our ability to measure plasma conditions is perhaps one of our best advances, one that I can demonstrate. Our scientists are becoming more and more familiar with plasma; more and more do they understand how plasma operates—but I think there is one thing that I can describe. Heretofore it was thought that one would require a rather large thermonuclear powerplant if one were successful, perhaps an output of the order of a thousand megawatts would be the smallest plant that one could envision. This indeed is a large plant. However, during the last year we have a clear understanding that if we can achieve the stable thermonuclear plasmas and obtain a steady state operation, we may be able to build devices of the order of 10 to 20 megawatts—relatively small machines. The achievement has been brought about because of scientists' better understanding the properties of sodium and aluminum at very low temperatures, the theory being that one might divert some of the electricity produced in such a machine to a refrigerator that would cool the coil that would in turn allow one to operate a much smaller device. I don't mean to say that we have a method yet for making 10- to 20-megawatt reactors, but I say if we can achieve the chain reacting plasma, it does appear that we can make a smaller reactor.

So during the last year I believe this was one of the more long-range advances that we made.

In addition, it is fairly clear that during the last year we have achieved neutron-producing plasmas of the order of 1 kilovolt—the equivalent to about 10,000,000°. This was done at Los Alamos in a machine called Scylla and also in the device at the Naval Research Laboratory. One should not look on this, however, as a major breakthrough, but as a milestone along a steady road toward our ultimate objective of obtaining thermonuclear energy under controlled conditions.

COST HISTORY

Mr. Cannon. Will you include in the record a tabulation showing estimates and actual cost of this program for the last 5 years?

Dr. McDaniel. Yes, sir.

(The information referred to follows:)

Physical Research Program—Comparison of amount available with actual cost experience

[In millions of dollars]

Operating costs	Amount available	Actual	Difference
Fiscal year 1955	40.7	41.6	0.9
Fiscal year 1956	45.7	46.7	1.0
Fiscal year 1957	65.7	59.3	−6.4
Fiscal year 1958	71.0	70.7	−.3
Fiscal year 1959	89.0	85.7	−3.3

OFF-SITE CONTRACTS

Mr. CANNON. And will you also insert in the record a tabulation of the off-site contracts on page 264?

(The information referred to follows:)

Division of Research: Offsite contract renewals, fiscal year 1960

	Number of contracts renewed	Dollar value of contracts renewed
Continuously in effect for—		
Less than 3 years	142	$7,243,116
3 to 5 years	126	5,716,592
5 to 10 years	91	5,642,320
10 or more years	67	10,541,146

Detailed listing of contracts in force for 10 or more years

Contractor and title	Investigator	Amount
PHYSICS		
Brown University: Reaction studies with fast neutrons	Peck, Russell A., Jr	$38,063
Carnegie Institute of Technology: 400 Mev synchrocyclotron and associated research.	Sutton, Roger B	777,694
Columbia University: Nuclear physics research	Havens, W. W., Jr	950,000
Duke University: Fast neutron cross sections and shell structure.	Newson, Henry W	198,050
Iowa, State University of: Research in nuclear structure	Jacobs, J. A	90,000
Minnesota, University of: 68 Mev proton linac	Johnston, Lawrence	469,411
National Bureau of Standards: Various research projects (physics portion).	Astin, A. V	57,766
Nebraska, University of: Energy transfer of slow ions	Jorgensen, Theodore, Jr	20,000
Office of Naval Research: AEC–ONR joint program in nuclear physics.		2,650,000
Ohio State University: Nuclear physics with a Van de Graaff accelerator.	Harris, J. C	58,000
Princeton University: 18 Mev cyclotron and associated nuclear physics research.	White, M. G	475,000
Purdue University:		
Research in nuclear physics	Bleuler, E	91,145
Basic research with high energy electrons and X-rays produced by a 300 Mev synchrotron.	Palfrey, T. R., Jr., and Tautfest, G. W.	114,011
Purdue Research Foundation: Modification of the Purdue cyclotron.	James, H. M	(1)
Rice Institute: Nuclear physics research	Bonner, T. W	114,034
Rochester, University of: Nuclear physics research	Marshak, Robert E	1,031,300
Texas, University of: Neutron experiments with a Van de Graaff generator.	Hudspeth, E. L	90,084
Washington, University of: 60-inch cyclotron development and research program.	Farwell, G. W., and Blair, J.S. (acting).	314,708
Wisconsin, University of:		
Nuclear research with electrostatic generators	Herb, R. G., and Barschall, H. H.	190,000
Structure of the nucleon, properties of strange particles, and weak interaction.	Sachs, R. G., and Ebel, M. E.	33,700
Low temperature research	Dillinger, J. R	12,00

[1] No funds.

Detailed listing of contracts in force for 10 or more years—Continued

Contractor and title	Investigator	Amount
Yale University: Isotope separation by thermal diffusion and nuclear studies with separated isotopes.	Watson, W. W	$16,000
Total, physics		7,790,966
CHEMISTRY		
Arkansas, University of:		
Nuclear chemistry research	Fink, R. W., and Fry, Arthur	93,173
Nuclear geochemistry	Kuroda, Paul K	32,000
California, University of: Intermolecular forces and solubility.	Hildebrand, Joel H	23,750
Carnegie Institute of Technology: Nuclear chemistry research.	Kohman, Truman P	64,958
Chicago, University of: Nuclear chemistry research	Turkevich, A., and Sugarman, N.	98,276
Columbia University:		
Separation of isotopes by chemical exchange	Taylor, T. I	49,844
Research in the field of radiochemistry	Miller, J. M	20,596
Isotope geology of uranium and lead	Kulp, J. L	45,000
Fordham University: Studies of coordination compounds and uranium chemistry.	Cefola, M., and Gentile, P. S	25,000
Illinois, University of:		
Studies in radiochemistry	Yankwich, Peter	26,000
Mechanism of molecular motion as determined from diffusion and thermal diffusion measurements.	Drickamer, H. G	33,100
Indiana University: (1) Studies on chelate complexes and (2) instrumentation in analytical chemistry.	Merritt, Lynne L., Jr	16,405
Iowa, State University of: Preparation of rare earth oxides	Vorres, Karl S. (acting)	20,000
Kansas, University of: High temperature research	Gilles, Paul W	71,000
Louisville, University of: Synthesis and properties of ion exchange resins.	Wiley, Richard H	13,338
Massachusetts Institute of Technology: Nuclear chemistry research.	Coryell, C. D., Hume, D. N., and Scatchard, G. E.	375,000
Michigan State University: Physico-chemical investigation of the interhalogen compounds.	Rogers, Max T	9,882
Michigan, University of: Low temperature chemical thermodynamics.	Westrum, E. F., Jr	19,500
National Bureau of Standards: Various research projects (chemistry portion).	Astin, A. V	324,267
Northwestern University: Mechanism of substitution reactions of inorganic complexes.	Basolo, Fred, and Pearson, Ralph G.	9,590
Notre Dame, University of: Radiation chemistry studies	Burton, Milton	490,472
Oklahoma State University: Separation of inorganic salts by liquid-liquid extraction.	Moore, T. E	10,300
Oklahoma, University of: Spectroscopic properties of fluorocarbons and fluorinated hydrocarbons.	Nielsen, J. R	7,086
Oregon State College: Study of generalized acid-base phenomena in nonaqueous ionizing solvents with radioactive tracers.	Norris, T. H	10,476
Pennsylvania State University: Stabilities of coordination compounds and related problems.	Fernelius, W. C	17,000
Pittsburgh, University of: Synthesis of beta-diketones and beta-ketoesters with heterocyclic nuclei and other related reactions.	Levine, Robert	14,995
Purdue Research Foundation: Studies in molecular spectroscopy.	Edgell, Walter F	39,000
Rochester, University of: Studies of spallation reactions	Wiig, Edwin O	16,200
Rutgers University: Polar inorganic molecules	Allen, E. R	21,500
Syracuse University: Mechanisms of some radiation induced gas reactions and the chemical reactions of electrons.	Burtt, Benjamin P	19,000
Tennessee, University of: Catalytic reactions involving deuterium.	Smith, Hilton A	12,330
Utah, University of:		
Study of surface chemistry phenomena	Eyring, H., and Christensen, C. J.	11,500
Ionization and dissociation of molecules by electron bombardment.	Wahrhaftig, A. L	14,000
Vanderbilt University: Spectra of some inorganic fluorine compounds.	Jones, E. A	7,062
Western Reserve University: Thermodynamic properties of gases.	Pace, Eugene L	12,270
Wisconsin, University of:		
Application of radioisotopes to chemical problems	Willard, John E	42,000
Studies of rates and equilibria in inorganic reactions in solution.	King, Edward L	27,970
Total, chemistry		2,143,840

Detailed listing of contracts in force for 10 or more years—Continued

Contractor and title	Investigator	Amount
METALLURGY		
Carnegie Institute of Technology: Electrochemical studies on nonaqueous melts.	Derge, G.	$66,000
Illinois, University of: Research on radiation damage	Seitz, Frederick	200,000
Massachusetts Institute of Technology:		
Study of radiation damage	Warren, B. E	8,000
Scope I. Thermodynamics and other aspects of metallic systems.	Bever, M. B	121,038
Scope II. Thermodynamics and structure of solid solutions.	Cohen, M	
Scope III. Imperfections in metals	Averbach, B. L	
National Bureau of Standards: Various research projects (metallurgy portion).	Astin, A. V	142,167
Pittsburgh, University of: Application of chemical thermodynamics and related phenomena to the study of alloy formation.	Wallace, W. E	31,442
Rensselaer Polytechnic Institute: Anisotropic self-diffusion in metals.	Huntington, H. B	30,675
Tennessee, University of: Application of adiabatic calorimetry to metal systems.	Standbury, E. E	7,020
Total, metallurgy		606,340

Summary of contracts in force for 10 or more years

Branch	Number of contracts	Amount
Physics	22	$7,790,966
Chemistry	37	2,143,840
Metallurgy	8	606,340
CTB	0	0
Total	67	10,541,146

Mr. CANNON. Are there further questions? The gentleman from Michigan.

UNIVERSITY OF MICHIGAN CYCLOTRON

Mr. RABAUT. Dr. McDaniel, we had before us from the University of Michigan recently Dean Ralph Sawyer, Dr. David Dennison of the physics department, and Dr. William C. Parkinson requesting equipment funds for a cyclotron. Do you agree with them that this cyclotron would permit the conduct of important basic research? I understand that it would be of a size that would be in-between some of the cyclotrons that are in existence. Would it duplicate any of the existing facilities? Do you know about it?

Dr. MCDANIEL. Yes, sir, I am familiar with this proposal.

Mr. RABAUT. I understand that this request was denied because of the budget ceiling.

Dr. MCDANIEL. It is true that this budget does not contain an item for this accelerator because of items of higher priorities which had to be included in the budget estimates. That is correct; yes.

Mr. RABAUT. Is it something that would be of great service or is it a duplication of an existing facility?

Dr. MCDANIEL. The accelerator itself as proposed would be a useful facility. I have had it reviewed by the scientific community and by the staff of the Division of Research and they are all of the opinion that it is a unique and worthwhile facility, and it is high on our list

of proposals for consideration. But I must add that the scientific community is able to submit proposals of this character almost endlessly because the number of problems that need solution is so immense. I have now in my possession proposals of this character which will total perhaps $200 to $300 million. Now, this proposal was given to us in 1958 by the University of Michigan and the request was was $1.8 million of Federal expenditure and the Michigan State Legislature would be asked to appropriate $1 million for the building to house this machine.

Mr. RABAUT. And privately they have several other millions of dollars that will go into this.

Dr. MCDANIEL. Yes. Up until the last few weeks my understanding is that the financial difficulties in the State of Michigan have prevented the appropriation of the money but that perhaps the State legislature was about to appropriate the money for it.

Mr. RABAUT. I understand they are about to appropriate it.

Dr. MCDANIEL. Within the limits of our program it was not possible to include this item.

Mr. RABAUT. It was not possible to include it this year?

Dr. MCDANIEL. That is right. I can offer little hope for the future except that I personally believe that the proposal is of very high quality, the scientists are outstanding, the financial proposal of joint participation to the extent of building the building is notable, and in general I do place it very high on our list for consideration in future budgets.

Mr. CANNON. If the gentleman will permit, will that require special authorization? It is a very large project.

Dr. MCDANIEL. This would be carried under the operating budget as equipment.

Mr. CANNON. It will not be necessary to have authorizing legislation?

Dr. MCDANIEL. It will not be necessary to have this authorized. I must also say that when the Commission or the Government purchases a machine of this character, consideration must be given to the future operating cost for the research program to be conducted with it. We have difficulties in projecting our operational budget into future years on this $200 million worth of proposals which I mentioned.

Mr. RABAUT. Do I understand from that that it will be necessary for the Federal Goverment to put in additional money or are you expecting that they would bear these operating costs?

Dr. MCDANIEL. As a general rule we have our operating contracts on a joint participation basis. The total funds which we put into a particular contract may be as much as three-fourths of the total project cost. In some cases our share at the cost will be as little as a half. But usually there are demands on the Federal Government for some operating expenditures connected with the utilization of the purchased equipment.

Mr. RABAUT. I notice in this new building they are going to spend about $7 million; $1 million is for space for this cyclotron. I thought you would probably have a little different feeling about this considering the reputation of the University of Michigan and the funds it would invest in this project.

Mr. McDaniel. We hold the University of Michigan in the highest regard. We do believe that financial participation by the State put a little different flavor on the project, but my reason for saying this is a good proposal is not based on financial consideration, but on the outstanding ability of the physics department to produce results and to produce a generation of new scientists.

The graduates from the University of Michigan have achieved worldwide fame.

Mr. Pillon. Mr. Chairman, may I take up a matter similar to the one taken up by the gentleman from Michigan?

The Chairman. Mr. Pillion.

PROPOSED LINEAR ACCELERATOR AT STANFORD

Mr. Pillion. Congressman Gubser of California expressed a keen interest in a proposed linear accelerator at the University of Stanford. I note that a present authorizing bill authorizes that project, something like $3 million. Is there anything in this budget for that linear accelerator at Stanford?

Dr. McDaniel. There is $800,000 in this budget to continue some of the reaserch and development associated with the early work of the accelerator, but there is nothing in this budget for the construction of the linear accelerator, nor is there anything in this budget for the $3 million mentioned in the Joint Committee authorization.

Mr. Pillion. As I understand it, the total cost of this accelerator would run in the neighborhood of $50 or $60 million; is that correct?

Dr. McDaniel. No, sir; it would be somewhat more than that.

Mr. Pillion. More than that?

Dr. McDaniel. The estimated cost of the accelerator and its associated facilities is $107.2 million as estimated by J. A. Blume & Associates, engineers. That is for the entire facility, sir.

Mr. Pillion. How would this linear accelerator differ and how would it not duplicate the machinery that you have now at, say, Harvard or Princeton? What is the justification for these astronomical figures?

Dr. McDaniel. The Stanford linear accelerator would be an electron accelerator. That distinguishes it from most of the other accelerators under construction. In this respect it would provide a tool for investigating electromagnetic interaction of the particles that the proton machine certainly will not allow one to do.

In the second place, it is a very high energy accelerator. The electrons will have an energy of 10 to 20 billion electron volts initially, in phase I, and if the scientific justifications exist 5 or 6 years from now, one could conceivably go to 45 billion electron volts, if the Congress would grant the authorization. The high energy electrons allow one to investigate the interior structure of fundamental particles which no other bombarding particle will allow, and in addition the Stanford electron accelerator will have a very high intensity. So there is a difference from previous accelerators.

This device would accelerate different particles and it would accelerate them to higher speed.

Mr. Pillion. These figures again puzzle me. I can build five or six nice big blast furnaces for that type of money, or almost a whole

steel plant. Now, what is the practical result of this accelerator? What are the prospects of putting the knowledge that we will obtain from this accelerator into practical use?

How will it aid our defense? How will it increase the wealth of this country? How will it raise the standard of living of our people? What is the possible practical value of all these accelerators, bevatrons, and the others? What are we getting at? What are we going to arrive at from an economic practical point of view with the spending of these sums of money?

Dr. McDaniel. If I could give you a definitive answer to your question, I would be a genius.

Mr. Pillion. It takes a genius to raise this money, too. We have to explain it back home.

Dr. McDaniel. All of the research which these machines will produce will add to the storehouse of human knowledge in a great many ways. First of all, the physicists who will be operating the machine will be able to learn how the universe is put together, what cements the particles together, what are the particles, what are their properties, what are their interactions. Now, this is something which does not produce a better wrapper for a loaf of bread. However, in the process of accumulating this information I for one am convinced that mankind will progress, but I can't lay my finger on exactly how and by what road mankind will progress.

BENEFITS FROM ORIGINAL CYCLOTRON

Mr. McCone. I would like to point out, Mr. Chairman, that years ago when at Berkeley, the original cyclotron was being built by Ernest Lawrence, this same question undoubtedly was raised by the University of California trustees when they were appropriating I think $300,000 rather than $107 million. And later I believe when a Rockefeller and other grants were made of with another million or two, this question was undoubtedly raised. I suppose the late Dr. Lawrence, brother of the man we heard here yesterday, had to give about the same answer that Dr. McDaniel just gave. But it is significant that from that cyclotron came the first fissionable material produced in this country which led the way to all that we have been talking about in these last few days. Dr. Lawrence could not have answered the question, as Dr. McDaniel could not answer it.

Mr. Pillion. I am just wondering about the limitations. There must be some limit on even theoretical knowledge no matter how fine it is.

Dr. McDaniel. We are not unmindful of the cost of the program. It is with a great deal of thought that we approach the Congress for these appropriations.

Mr. Pillion. I understand that.

Dr. McDaniel. Yes.

Mr. Cannon. Mr. Jensen.

AGRICULTURE—EXTRACTING ALCOHOL FROM GRAIN

Mr. Jensen. Now, turning to agriculture, we placed in this year's bill $10,000 for research into the possibility of extracting alcohol from

grain by the isotope method. Who is here who can tell us what the outcome of that research is?

General LUEDECKE. Mr. Jensen, we sent the committee a letter covering our efforts on that this year, but Dr. Aebersold, head of the Isotopes Division, is here, and I think he can answer your question.

Dr. AEBERSOLD. Sir, we planned to cover this item later when our testimony on isotopes development comes up. I can cover it now if you wish.

Mr. JENSEN. Why not do it now?

Mr. CANNON. You may proceed.

Mr. JENSEN. Yes.

Dr. AEBERSOLD. This is the report on the subject "Utilization of Radiation for the Conversion of Grain to Chemicals," which was transmitted to the committee. I thought you had seen it.

Mr. JENSEN. No; I am sorry; I have not.

Dr. AEBERSOLD. The problem is that grain is an expensive starting material to develop bulk chemicals as cheap, for example, as industrial alcohol. One can start with petroleum and also make ethyl alcohol. That was an interesting thing that I had not realized, that ethyl alcohol, good grades of industrial ethyl alcohol, made cheaper from petroleum than from grain.

Industrial alcohol is now produced from petroleum. Grain is considered too expensive a starting material for producing bulk chemicals. This report indicates, however, that there may be some more expensive types of chemicals, more complicated organic compounds, which might be developed by irradiating grain. However, there has not been very much research done in that field, and research groups in the Department of Agriculture would like to have an irradiator to make research studies on the chemical effect of irradiation on grain.

Mr. JENSON. I can only say that, of course, grain at the present time is considered very expensive by we folks from the farm district and the reason is that——

Mr. CANNON. Off the record.

(Discussion off the record.)

Mr. CANNON. On the record.

Mr. JENSEN. Now, we of course know that we extract alcohol, among other things, from coal. The coal industry beat the agriculture industry to the draw by getting bigger appropriations to do research on what products could be produced from coal. But the facts are that agriculture, being our basic industry, is suffering today because of an oversupply of grain, and we know that before the advent of the automobile, horses and mules used to eat the production of some 40 million acres of our land. We missed the boat a million miles when we did not process that surplus grain into alcohol and mix it with our motor fuel. Had we done that we would have no farm problem today. Not only the farmers but the whole economy would have been in a much better condition. So I would not like to take your reply, doctor, as final in this field of research relative to extracting alcohol and other products from grain.

Now, have you and the Commission closed your eyes, so to speak, and reached the end of the road on this very important matter?

Dr. AEBERSOLD. No, sir. This report recommends that more research be done on the effect of radiation on organic materials, on

agricultural products, and particularly on finding other uses for agricultural products or byproducts.

Mr. JENSEN. Do you have money in this bill now to do research?

Dr. AEBERSOLD. We have some funds for activities on food irradiation, but not specifically on grain.

Mr. JENSEN. After all the oversupply of grain is the great problem that the farmers and this Nation have. We have about $6 billion invested in grains stored by the Commodity Credit Corporation. Until we can reduce that great surplus to normal granary size the farmers are going to be in a bad fix. Of course, I do not expect it will be possible, but it seems that the Atomic Energy Commission have been doing the impossible, and maybe they can do it in this respect. I am very serious about this. I certainly am not going to be unfair about it, but I realize the potential in this field, but I would not like to have it said that this is the end of the road.

Do you feel, Doctor, that the committee would be justified in making more money available for this purpose or do you feel that it is a hopeless case?

Dr. AEBERSOLD. In the case of alcohol from grain, as I said, making it from petroleum is equally a good type of alcohol for industrial purposes. This report shows that it can be made cheaper that way.

Mr. JENSEN. Right there, Doctor, I hoped that by your method of doing things through the isotope system you might discover a very much cheaper way to extract alcohol from grain and that is why I asked the committee to include this $10,000 item last year for this purpose. Now we know, of course, that alcohol is being extracted from grain to some degree right now, but I hope that a cheaper method could be found for the extraction of alcohol.

Dr. AEBERSOLD. This report suggests research in other directions to make use of agricultural byproducts for other purposes than for food. I would like to suggest that the report be transmitted to you.

Mr. JENSEN. I will read every word of it.

Dr. AEBERSOLD. There are a number of interesting recommendations in it. We cooperated with the Department of Agriculture very closely on this study and they have indicated some areas in which they would like to do research.

Mr. CANNON. Off the record.

(Discussion off the record.)

Mr. CANNON. The committee will resume at 2 o'clock.

AFTERNOON SESSION

BIOLOGY AND MEDICINE

Mr. RABAUT. We shall now take up "Biology and medicine," $54.2 million. Insert pages 171 through 202 in the record at this point.

(The justification follows:)

BIOLOGY AND MEDICINE PROGRAM—OPERATING EXPENSES

Program statement

Estimate, fiscal year 1961	$54,200,000
Estimate, fiscal year 1960	49,000,000
Increase	5,200,000

The fiscal year 1961 budget for biomedical research was prepared in order to meet the changing needs of the Atomic Energy Commission in fulfilling its responsibilities under the Atomic Energy Act of 1954 as amended to assure that the Commission's expanding operations are carried out with full regard for the public safety, to continue to exploit nuclear energy and its byproducts in biomedical research for the welfare of the country, and to meet the Commission's responsibilities to the newly established Federal Radiation Council.

There has been a moratorium on weapons tests for the past 12 months, but during this time the first land-based prototype nuclear propulsion unit for rockets has been successfully tested in Nevada. Other nuclear propulsion prototypes for our national space and atmospheric transport program will probably be tested in the coming months. In other words, the potential for radioactive contamination of the atmosphere grows rather than diminishes and the need for better estimating the hazard and for developing the means for its control have grown. It is thus absolutely necessary to make optimum use of the present radioactive debris in the upper atmosphere as a basis for arriving at valid conclusions as to rates of fallout and distribution of materials introduced in the high as well as the lower stratosphere. The short half-lives of some of this material presently in the stratosphere make these studies especially urgent. This program will be intensified in fiscal year 1961. The fallout studies program has been reoriented to a more long-range study of the nature and fate of fallout with less emphasis on monitoring of a surveillance type such as is now being undertaken on an expanding basis by the Department of Health, Education, and Welfare.

As more and more nuclear propelled ships are commissioned the studies of fission product movement, concentration and turnover in the oceans and other waterways become more urgent as was indicated by the recent report of the National Academy of Sciences Committee on Oceanography.

The problem of fission product toxicity increases as we learn more about the behavior of these radioelements. Consequently, this aspect of the program, especially as it relates to mixed fission products, will expand in fiscal year 1961, with renewed emphasis on inhalation as a mode of entry into the body.

The past year in both the genetic effects field and in the cancer effects field evidence has come to light indicating a dose rate relationship to the effect produced. These observations must be expanded and carried further as rapidly as scientific manpower becomes available until a completely sound basis for setting acceptable levels of exposure of both industrial workers and the public as a whole has been achieved. Meanwhile efforts are being intensified to understand the basic mechanisms involved at the molecular level following the initial ionizing event.

In the absence of nuclear weapons tests our efforts to understand the civil effects must lean heavily on exploiting the data becoming available from past tests and from the Atomic Bomb Casualty Commission. Further we must improvise experiments which will settle most points. We will expend less money in this area in 1961, but nevertheless plan to expand our knowledge in this field.

Our program of leadership in exploiting the beneficial uses of atomic energy in biology and medicine will continue with the increased costs going principally for fuller utilization of the Brookhaven National Laboratory medical center, the Brookhaven National Laboratory sciences program and the University of California experimental treatment of cancer with the 184-inch cyclotron, and research and development concerning the feasibility and acceptability of low level radiation processing of foods.

The increase of $5,200,000 requested for fiscal year 1961 is set forth by category and activity on the following pages.

Summary of estimate by category

Category	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
1. Radiation effects on biological systems	$14,967,987	$16,830,000	$18,935,000
2. Combating radiation detrimental effects	2,165,684	2,373,000	2,707,000
3. Beneficial applications of atomic energy	10,410,090	11,370,000	12,010,000
4. Biomedical problems in atomic energy operations	9,255,376	12,469,000	14,398,000
5. Dosimetry and instrumentation	2,193,538	2,602,000	2,927,000
6. Civil effects test program	1,226,566	1,400,000	1,035,000
7. Equipment not included in construction projects	1,788,516	1,956,000	2,188,000
Total biology and medicine program	42,007,757	49,000,000	54,200,000

JUSTIFICATION OF CATEGORIES

1. Radiation effects on biological systems, $18,935,000

(*a*) Medical research:

Fiscal year 1959	$6,097,087
Fiscal year 1960	6,656,000
Fiscal year 1961	7,099,000

The medical research in this category is intended to provide a better grasp of the effects of radiation on plants, animals, and man so as to be able to estimate more precisely the radiation hazard to people.

Studies on internal emitters—radioactive isotopes deposited in tissues within the organism—now cover the whole range of laboratory animals and include man himself. These isotopes are chiefly tritium, carbon 14, phosphorous 32, sulfur 35, calcium 45, strontium 85, strontium 89, strontium 90, yttrium 90, iodine 131, cesium 137, radium 226, radium 228, uranium 235, uranium 238, plutonium 239 and certain elements in the thorium and rare earth series which come under scrutiny because they are a product of fission or are hazardous to atomic energy operations. Such researches are components of a continuing program whose object is to be able to recognize and measure the local and distant radiation effects of such radioactive deposits and to relate these effects to the clinical status of men who might be exposed to one or more of these elements. Further refinements of these studies are expected to demonstrate those concentrations of radioisotopes which produce no or statistically negligible effects.

These studies will be expanded to systematic medical observations of human subjects. In addition to the surviving watch dial painters exposed to radium 226 and/or radium 228 there are groups of industrial workers who are carrying varying amounts of plutonium 239, uranium 238, and uranium 235 in their bodies; it is expected that others will pick up radioisotopes of thorium and other elements currently being utilized in the atomic energy industry. These will be studied by the controlled low level facility (whole body counter) and by whatever detailed radiochemical procedures are applicable to samples of tissues, expired air, and excretae.

Data currently available clearly indicate that the biologic behavior of many of the above radioisotopes in animals differs from that in man and hence studies of this behavior in man will be expanded both opportunistically and by planned controlled experiment. The whole body counter is the key equipment used for such planned studies and the further development and use of this equipment is being supported wherever the talents and intents of a group of investigators warrant such an installation. A byproduct of such planned experiments is that over long periods will come the data, ratios, and factors correlating body burden with intake of activity in foods and water and/or with rates and absolute amounts of activity in the excretae. Such figures are needed to specify realistically the values for maximum permissible concentration and maximum permissible level published in the National Committee on Radiation Protection Handbook.

Studies of the effects of irradiation of the nervous system are being expanded following claims by foreign radiobiologists that the nervous system functioned differently following very low doses of radiation. This has not been corroborated thus far but work will continue to obtain additional data on this very crucial question. Observations on the local effects of heavy particle irradiation from cosmic rays, the 900 MEV alpha accelerator, the B^{10} (n, alpha) L^{7} reaction will supplement and extend the studies using conventional irradiation. Additional research will be directed to the development of new methods for measuring the neurologic changes following irradiation since the conventional histologic and physiologic methods have not proven sufficiently sensitive to identify subtle changes. Such new techniques are expected to become available as a result of sophisticated neuropharmacological and electroencephalographic experiments now underway. Both central and peripheral nervous tissues will be investigated further for their probable reactions to irradiation.

A major effort will continue to be directed toward understanding the suppression of tissue immunity induced by near-lethal doses of whole body radiation. This suppression of immunity has two concurrent effects: (*a*) It exaggerates the radiation syndrome by facilitating bacterial invasion followed by generalized infection and death; and (*b*) makes possible the acceptance of foreign bone marrow cells which will find their way to the host's depleted bone marrow and for a time at least be the source of working red and white blood cells. It is expected that the major work in these fields will center around

studies designed to: (*a*) identify the cell(s) involved in the host's immune reactions; (*b*) define the mechanisms by which tissue antigens cause these cells to produce the several types of antibodies; (*c*) describe the nature of these proteins and the way they are carried about in the blood and tissue spaces; and (*d*) discover what type of cells are best tolerated by the irradiated recipient.

Accidental near-lethal exposures of man fortunately have been too few to provide sufficient clinical material to carry out these experiments with the result that use will be made of every possible analogous clinical condition which will give some hope of learning how to deal with this potentially lethal hematological defect produced by whole-body radiation.

From these clinical studies should come data which combined with analogous data on animals will serve to complete the many gaps in our knowledge of the biological changes following potentially lethal doses of radiation. The Oak Ridge, Los Alamos, and Yugoslav accidents, although only a few persons were involved, have caused a major review of the biochemical and biophysical changes after whole body exposures with the result that a number of new ideas and leads will be explored to the fullest extent permitted by facilities and personnel. Hopefully the studies and analyses will permit the identification of more of the multitudinous chemical and physicochemical changes taking place in tissues, organs, cells and subcellular units relative to different doses of radiation. Present researches will be extended to clinical biochemical tests capable of evaluating the biological seriousness of whole body radiation exposures in man. At the very least, it is anticipated that it will be possible to estimate absorbed rad dosage from neutron exposure from knowledge of the sodium 24 activation plus the spectral energy ranges of the neutron flux.

The late or chronic effects of prior irradiation will continue to receive significant attention but because of the necessity of observing animals (and man) throughout their life spans, the overt progress of such studies appears slow. The results from experiments now in progress are expected to fill in more qualitative and perhaps some quantitative details of the recognized gross effects of significant amounts of whole body exposure, namely, carcinogenesis, leukemogenesis (cataract formation, nephrosclerosis, and accelerated aging with shortened life span. These aspects are being correlated with other studies on the aging process of populations such as the epidemiology of natural aging and the effects of variations in normal radiation background.

The experiments in progress include both total and fractional, single and repeated external exposures by gamma rays and neutrons, together with various doses and types of internal exposures as obtained by a variety of radioactive isotopes. The studies of the late effects of irradiation on the populations of Nagasaki and Hiroshima by the Atomic Bomb Casualty Commission is an excellent prototype of the kind of long-term experiments required to investigate "chronic effects." Wherever possible the animal experiments have been planned so as to simulate situations which have occurred or may arise with respect to man.

A new line of research made possible by recent advances in engineering and design is planned in which the key element is a pulse of radiation—fast neutrons or 300 Kev X-rays—produced within one-millionth to one-thousandth of a second. Such brief pulses of radiation simulate the pulse from a weapon and since they can be varied at will to suit the design of the experiment are incomparably superior to the pulses obtained from single-shot weapon tests or other radiation sources. Practically nothing is known of the biologic effects or effectiveness of a practically instantaneous pulse of pure electromagnetic and particle radiations and thus it cannot be predicted what the significance of the findings will be. At the very least, however, all current theories of the effects of ionizing radiation on animate and inanimate objects must be tested against the results secured when the same amount of radiant energy is delivered to the object within about one-millionth of the conventional time of experimental exposure. From the practical standpoint the dosimetry of brief pulses of radiation can now be studied and developed as well as the behavior of certain components such as transistors, radiotubes, and detector components under these conditions. This line of research is long overdue for intensive investigation, but up to now the physical radiation sources have not been available.

(*b*) Biological research:

Fiscal year 1959	$8,072,317
Fiscal year 1960	9,266,000
Fiscal year 1961	10,684,000

Much of the past research effort in this activity has been concerned with two very critical problems in radiobiology: (*a*) Improving the physical measurements of the dose absorbed from both external radiation and internally deposited radioisotopes; and (*b*) quantitatively determining the biological changes (such as mutations, tumor formation, cataract formation, death, etc.) which appear hours, days, weeks, months, or even years later. However, the accumulating knowledge from these studies has demonstrated that even in cases where there are good measurements of the dose neither the extent of the resulting biological change nor the exact time of its onset can be precisely predicted. This is of course not surprising because individual biological changes are undoubtedly initiated by different biochemical events. As this fact has become more obvious in recent years, an increasing effort has been directed toward more fundamental studies of the biophysical and biochemical effects of radiation.

From past studies it is known that as much as one-million roentgens are required to produce appreciable "inactivation" of a specific biochemical in either the dry state or in a solution containing a number of other biochemicals—such as would be present in a cell. Yet, one-thousand roentgens or less may be adequate to kill a significant number of some organisms or individual cells. Numerous explanations of this thousandfold disparity have been advanced and are under investigation; for example—

(*a*) Radiation destroys certain critical cellular components of which there is only one-of-a-kind per cell; or

(*b*) Radiation-produced disturbances in the delicately balanced cellular metabolism become amplified; or

(*c*) Radiation either produces poisonous products or else modifies the internal structure and cellular wall so as to allow essential compounds to leak out or poisonous compounds to get in; or

(*d*) The mechanisms of energy interchange within biological systems is such that absorbed energy is funneled to critical sites.

Work is in progress in all of these areas and a continuing expansion in each is necessary to provide a better understanding of the basic nature of radiation damage. Critical cellular components such as enzymes and nucleic acids have been purified and their response to radiation studied. A large increase in emphasis will be placed upon investigations of how the radiosensitivity of individual cell components varies depending upon whether they are irradiated inside the cell or completely isolated from it.

Most radiobiological research has been concerned either with physical measurements of the absorption events which occur in the first 10^{-12} (one-millionth of a millionth) seconds or with determinations of biological effects which appear quite some time after exposure. The problems which have evolved from these studies show the need for knowledge of the processes occurring in the in-between time range. As a result, much of the present effort, as well as that planned, is directed at studies of the cellular events which occur in the first few minutes or hours. However, the largest increase will occur in studies of those processes which occur in the even more restricted time region of 10^{-9} (one-thousandth of a millionth) to 1 second after the absorption of energy. It is expected that knowledge of the mechanisms involved will permit an understanding of how cellular structures mediate the movement of energy absorbed from ionizing radiation from its point of initial absorption to critical sites within the cell.

The genetic materials are critical cellular components which are fairly susceptible to ionizing radiation. Major research emphasis in this area is the development of genetic data necessary to provide an accurate estimate of the radiation genetic hazard to man. The expression and elimination of detrimental mutations in human populations is not well understood and conflicting hypotheses of the genetic structure of populations presently exist. An expansion is planned for studies designed to trace the accumulation, manifestation and ultimate elimination of radiation induced mutations in populations. These can be carried out with suitable laboratory plant and animal species and, wherever feasible, human populations will be surveyed.

An effort will be made to improve our knowledge of the selection pressures that act on human populations and the effects of these pressures in determining the frequency or incidence of detrimental mutations. Some mutations may appear in direct proportion to the mutation rate while others may accumulate to levels far in excess of what could be attributed to spontaneous mutation alone since they may confer some selective advantage to the carrier. It appears possible

that a portion of the tangible genetic defects we see in man may behave in this manner. Continued support and expansion of studies of children of consanguineous marriage is vital for estimations of the mutation load normally present in man.

Many mutations have a subtle detrimental effect; for example, they may reduce growth rate, increase disease susceptibility, reduce reproductive performance or reduce the life expectancy. Existing programs, such as the Oak Ridge National Laboratory mouse genetics and the Iowa State University swine genetics programs, require increased support in order to contribute to our understanding of these less tangible forms of genetic injury.

The Oak Ridge mouse genetics studies have demonstrated that continuous radiation exposure at low intensities is significantly less mutagenic than exposures delivered acutely. This is extremely important for considerations of the effect of occupational and fallout radiation hazards and emphasized the need to better understand the chemical nature of genetic material and the manner in which radiation acts to change it. The lesser mutagenic effect of low intensity radiation provides new leads on the study to determine means of preventing or ameliorating genetic damage.

Investigations of the variations in radiation induced and spontaneous mutation rates in different species, at different stages of development, and under different physiological conditions will be continued. Radiation exposure produces considerable damage to the chromosomes as well as to the genes they carry. Chromosome damage is probably ultimately responsible for most cell death in irradiated tissues and for most early-acting genetic lethality in embryos. Studies on this aspect of radiation genetic damage will continue.

Neither the genetic nor the somatic effects of radiation damage arising from ingested radioactive materials have been critically evaluated insofar as their respective contributions to the damage are concerned. This damage could arise from the radiation given off by the decaying nuclide or it could rise because of the breaking of a chemical bond upon the transmutation of the radioactive element during decay. Studies designed to evaluate these two mechanisms will be expanded, especially in comparing the relative effects of the radiation damage and the damage due to transmutation. These studies are particularly important since at least two common radioactive elements, carbon 14 and phosphorus 32, are constituents of genetic material.

Most of our knowledge to date concerning the biological effects of radiation has been developed from research on small laboratory animals. Experience gained from these studies will be applied with increasing emphasis to defining more clearly the pathological and physiological effects of radiation in larger domestic animals. Experimental data derived from larger animals can frequently be extrapolated directly to man because of closer similarities in body sizes, organ systems, and the voluminous data on breeding and performance records. Specific biological responses that require quantitating are hematopoietic and gastro-intestinal injury, carcinogenesis, cataractogenesis, effects on endocrine and immune systems, effects on fertility, sterility and progeny, life shortening and decrement in physiological performance.

(*c*) Biophysics research:

Fiscal year 1959	$415,802
Fiscal year 1960	413,000
Fiscal year 1961	417,000

Radiological physics and dosimetry is the study of the effects of radiation on matter. The principal purpose of the research in this activity continues to be the development of techniques and methods for measuring radiation in order that interpretation of possible damaging effects of radiation on man can be made. The following projects in radiological physics will be supported: (1) The continuing study of the slowing down of electrons in metals; (2) calculation of neutron dose in various phantoms and estimation of neutron dose to tissue and neutron induced activation of blood sodium; (3) study of the attenuation of neutrons and gamma rays in connection with the Ichiban program; (4) electron capture and agitation experiments with particular emphasis on energy and charge transfer in ion-molecule collisions; (5) measurement of stopping power of low energy (below 10 Kev.) electrons in very thin metal foils and in tissue-equivalent plastics; (6) studies of ultraviolet light output of irradiated materials; (7) measurement of cross sections for energy transfer to solid media from high-energy particle beam; (8) further studies and

development of neutron dosimetry techniques including proportional counter studies.

(*d*) Environmental sciences:

Fiscal year 1959	$382,781
Fiscal year 1960	495,000
Fiscal year 1961	735,000

A substantial expansion in studies of radiation effects using terrestrial and aquatic plant and animal populations is planned during fiscal year 1961.

The construction of reactors, the past detonation of nuclear devices and the disposal of radioactive materials in areas away from human habitation has placed emphasis on the need for investigations concerning indirect effect of radiation on man. Radioactive byproducts of atomic operations intensify one factor in the environment and this in turn may alter others, notably those of a biological character, which in turn affect the total environment of man also the environments of plants and animals which produce food and raw materials essential to his living. Present studies will be expanded to develop data concerning (1) background radiation levels in uncontaminated areas; (2) effects of prolonged low-level radiation on native populations of organisms and (3) establishment of specific effects of various radiation doses on plants and animals that may serve to distinguish between the effects of radiation and of other somatic or genetic changes.

Projects will be continued toward the establishment of background levels of radiation in sites proposed for reactors and other nuclear installations. Observations will be increased of natural trends, periodicities and fluctuations of the biotic populations and environmental complexes in reserve areas of landscapes characterized by grass, coniferous forest, deciduous forest, desert shrub and woodland. These areas will serve as points of reference for studies of possible contamination in the future. Populations of organisms exposed to radiation will be studied intensively at Rongelap Atoll and in other areas where past detonation studies may document the succession of organisms in areas that were exposed to considerable radiation. Cessation of testing has resulted in somewhat higher costs for the Rongelap studies because of the removal of support facilities that were formerly available. Studies of long-term effects of radiation on populations in aquatic and terrestrial environments, whether natural or man modified, will represent an increased effort.

2. Combating radiation detrimental effects, $2,707,000

(*a*) Medical research:

Fiscal year 1959	$1,050,617
Fiscal year 1960	1,208,000
Fiscal year 1961	1,311,000

The nature of problems of combating the detrimental effects of ionizing radiation in living systems are largely determined by the amount and quality of the radiation. Laboratory animals have been protected from lethal doses of external gamma and neutron irradiation using the organic chemical compound AET (S,2 aminoethyisothiuronium Br-H Br) and several other similar compounds given immediately preceding radiation exposure. However, these compounds are less effective in rats and monkeys, because toxic effects of the drug cancel out the protective action; also there is a definite limit to the range of dosage where they exert a protective action.

Until recently, it has not been possible to administer a protective dose of AET (S,2 aninoethyisothiuronium Br-H Br) to a dog. The toxic reactions have been decreased, however, by using different routes and methods of administration; these techniques remain to be investigated in man. The search for new types of compounds will continue and all promising leads will be explored.

Bone marrow transplantation has been shown to be extremely effective in promoting the recovery of mice from acute radiation injury. The first trials in dogs and monkeys were not encouraging. During the past year the development of more sophisticated techniques has unquestionably established successful bone marrow transplants in irradiated dogs. The success of the treatment in dogs demands continued investigation of methods of application to human subjects. A major line of study will be the possible utilization of fetal bone marrow for transplants.

One method of attacking this problem in humans is to attempt to treat leukemia by irradiating the entire body of the patient with the hope of destroy-

ing the diseased marrow and then replacing it with healthy transfused marrow. No permanently successful cures have been achieved. On the other hand, the patients with anemias who have not responded to conventional therapy, have in many cases shown dramatic improvement following bone marrow infusions. These results remain to be confirmed by other investigations.

Radiation has been employed in attempts to modify the rejection of transplanted organs, for example, the kidney. Prior to this use of radiation, the only successful transplants in patients have been carried out with tissue obtained from an identical twin, but now the pretreatment of a patient by a large dose of gamma radiation delivered to the whole body, with supporting bone marrow therapy, is encouraging surgeons in their attempts to evolve a successful transplantation technique which overcomes the immune defenses of the human body. Studies to provide information in the immunological reactions of transplanted marrow in the human host, the selection and processing of human marrow, and the preservation and evaluation of frozen or otherwise preserved marrow will receive increased support during fiscal year 1961.

The other major source of damaging radiation to the human body, internal emitters, is of interest from the industrial standpoint. Accidental ingestion and inhalation of radioactive materials occurs in nuclear manufacturing and processing operations. Other radiation incidents may on occasions provide a hazard to the general population. Accurate and rapid estimation of the radioactivity retained by the body is necessary for proper treatment of the patient. Methods increasing the excretion of the ingested isotope have been worked out for several elements. However, no effective technique has been established for decreasing the body burden of many of the bone-seeking elements, such as strontium 90. Synthesis and testing of new chelating agents for this purpose will continue. It is expected that studies of the physiological and biochemical mechanisms controlling metabolism of mineral elements may subsequently lead to more useful methods of decontamination, and therefore warrant increased support.

The delayed effects of sublethal doses of radiation as well as effects caused by long exposure to low levels of radiation have received increased attention during the past several years. Projects for the study of radiation mortality are being extended to determine whether treatment with antiradiation drugs or dietary factors, will modify or delay the appearance of the late effects, such as life shortening, carcinogenesis, and kidney damage.

(*b*) Biological research:

Fiscal year 1959	$1,115,067
Fiscal year 1960	1,165,000
Fiscal year 1961	1,396,000

Increasing evidence of the wide variations in the sensitivity of different organisms to radiation damage is accumulating. Thus, some organisms show an observable effect after receiving 0.1 roentgen of ionizing radiation whereas others can grow in the water used as a moderator in a reactor where they may receive as much as 1 million roentgens. Studies of the fundamental biochemical and biophysical mechanisms underlying this "tolerance" of radiation by some organisms may well lead to the discovery of substances which will offer protection against radiation damage. It seems particularly important to investigate these phenonmena at all levels; i.e., at the subcellular, the cellular, and the organ system as well as at the level of the whole organism. Research in the following areas will be expanded in fiscal year 1961:

(1) Little is known of the biochemical processes occurring during recovery from sublethal doses of radiation. Studies of this important area are expected to be of value in developing substances to accelerate recovery or to prevent damage from radiation. Investigations utilizing micro-organisms are particularly valuable as pilot studies of the biochemistry of radiation protection and recovery. For example, bacterial strains are known which are highly resistant to radiation apparently due to the intracellular accumulation of a sulfhydryl compound as a normal metabolic byproduct; conversely, some strains are extremely sensitive apparently due to the hereditary absence of certain porphyrin-containing enzyme systems.

(2) Expansion of studies on methods of removing or of preventing the uptake of internally ingested radionuclides is anticipated. In particular, studies concerned with factors which influence the absorption of strontium and cesium from the intestine either by complexing with them or in some other way preventing their uptake will be initiated.

(3) Attempts will be made to determine more precisely the importance of damage to the genetic apparatus of somatic cells in causing cellular death or alteration in metabolism. Such studies are of importance in fully understanding the basic causes of radiation sickness and many of the chronic effects of radiation such a carcinogenesis, cataract formation, and life shortening.

(4) Biological research on the immunological responses of irradiated animals and tissues will be expanded. Research is needed not only on the difficulties resulting from immunological responses encountered during bone marrow transplantation but also on the changes in immunity to other substances of biological importance resulting from radiation damage. New long-term projects will be initiated utilizing large domestic animals to study the radiotherapeutic value of bone marrow and other tissue extracts and related immunological factors. Some progress has already been reported in the use of autologous bone marrow transplantation in cattle and chemical radioprotectants have proved effective in small laboratory animals. Results of these studies may be directly applicable to man.

(5) Continued efforts will be devoted to the development of radioprotective drugs that afford protection and also have a low toxicity. Important leads for synthesis of drugs in the future may come from studies on substances occurring naturally in the body that appear to counteract radiation damage.

(6) The repair of radiation-produced chromosomal damage is apparently dependent upon the availability of energy in the form of high energy phosphate compounds in the cell. Environmental and metabolic factors which increase the availability of these materials in the cell will be investigated. An increased emphasis will be placed upon determining the biochemical nature of the enhancement of X-ray induced breakage of macromolecules and structures such as the chromosome by far red light and the reversal of this enhancement by red light. These studies are expected to lead to a better understanding of the mechanisms involved in early stages of radiation damage. Work will be expanded on the mechanisms of recovery from the radiation-produced blocking of cell division, since such blocking may play an important role in the acute radiation syndrome in mammals.

3. Beneficial applications of atomic energy, $12,010,000

(a) Cancer research:

Fiscal year 1959	$4,029,137
Fiscal year 1960	4,412,000
Fiscal year 1961	4,657,000

The construction of previously planned facilities, including high energy ion accelerators for use in the cancer program has reached completion. Consequently, in fiscal year 1961 the operational level and the tempo of the research effort will increase slightly.

The recently completed medical reactor at Brookhaven National Laboratory provides a tool which will have far-reaching effects on the treatment of certain malignant brain tumors, and research will be conducted to explore its potential usefulness in other types of malignancies. It is expected that the patient load of 48 beds will reach full capacity in fiscal year 1961.

Other radiotherapeutic studies will be continued at the Oak Ridge Institute of Nuclear Studies with both cesium and cobalt units, and in addition the newly constructed irradiation facility for the total body irradiation of leukemias followed by bone marrow infusion will be functional. From such a study information will be gained not only pertaining to therapy of leukemia patients, but also to the problems associated with organ grafts, including skin.

Additional radiotherapeutic research will center around the 70-Mev. synchrotron at the University of California Medical School in San Francisco. Here the effects of high energy X-rays in the treatment of selected tumors (lung, cervix, tongue, and bladder) are being studied in human patients. To date the number of patients treated is too small and the elapsed time too short to permit any final conclusion as to the place this tool is to take in the treatment of cancer.

At the Argonne Cancer Research Hospital cancer patients will continue to receive deep therapy from both the 2-Mev. Van de Graaff and the 2,800-curie cobalt source. The recently completed 50-Mev. linear accelerator at Argonne Cancer Research Hospital represents a new approach to electron therapy in that one can vary the electron energy. The emergent beam in this particular

unit can be adjusted between 5 and 50 Mev. In addition to the variable energy, this unit is equipped with a magnetic deflecting and scanning unit which provides variability in beam direction and treatment area required in practical radiation therapy. Patient treatment has begun on patients with head and neck tumors and will be extended to other types when the capabilities of the instrument are better understood.

Irradiation of the pituitary gland, using the proton beam of the 184-inch cyclotron at the Lawrence Radiation Laboratory, will be continued in patients with advanced breast cancer. Though the application of this technique has limitations, results to date have been sufficiently encouraging to continue research efforts in this area.

The development of various brachytherapy devices will continue in fiscal year 1961. Clinical and experimental work continues with the various soft X-ray emitting-type isotopes which have been found to be well suited as a means of delivering interstitial radiation for the treatment of malignancies. Among them palladium 103 has been used to treat several patients with advanced tumors; yttrium 90 is still being used with success to destroy the hypophysis of patients who have metastatic carcinoma of the breast; and iodine 131 encased in polyethylene applications has been implanted in patients with inoperable carcinomas.

Supporting these clinical applications will be studies directed toward the refinement of techniques and instrumentation concerned with more precise detection and localization of tumor masses. The use of the positron-emitting isotopes (i.e., astitine 74, manganese 52, and copper 64) and also such gamma-emitting isotopes as iodine 131 will continue to be explored in brain tumors as well as other type malignancies, including metastatic growths. It is hoped that calcium 47 will be available by fiscal year 1961, and this isotope will have useful application in bone metastases. Further development of mobile and "area" scanning devices will be pursued.

It is expected that the red blood cell stimulating substance, "erythropoietin," will have been available by fiscal year 1961, for clinical trials. This substance promises to be most effective in treating certain refractory anemias sometimes seen in cancer patients, for which there is no treatment other than transfusion at the present time. It also offers potential in the treatment of blood conditions wherein blood formation is suppressed, as in radiation sickness.

Studies will continue on the effectiveness of triiodothyronine in potentiating the biological action of ionizing radiation. The use of triiodothyronine in conjunction with radiation in the control and ablation of various tumors has been found to be effective both in clinical patients and in experimental animals, although some toxicity has been noted in patients subjected to long treatment. Refinement of this technique will continue.

Immunologic studies will receive continued emphasis in fiscal year 1961. Further estudy of the recently initiated attempt to treat cancer of the thyroid by an immunologic attack on the antigen in thyroglobulin will be made. In addition, fundamental studies directed toward determining the earliest link in the chain of events leading to immunologic rejection of grafts of foreign tissues will be pursued.

Rather extensive metabolic studies continue in both normal and cancer patients, as well as in animals, following the administration of metabolically important substances labeled with carbon 14. The excretion patterns are being followed to detect changes that occur in cancerous conditions, as well as following whole body radiation injury.

Studies in both radiation and chemical carcinogenesis will continue with equal emphasis in fiscal year 1961.

(*b*) Medical research:

Fiscal year 1959	$2,711,528
Fiscal year 1960	2,851,000
Fiscal year 1961	3,074,000

Investigations of the use of radioactively labeled compounds in biochemical and biophysical studies of normal and disease processes in man and experimental animals will be continued and expanded. Tritium, for example, is being used increasingly to determine the performance capacity and durability of various cellular and tissue components. Incorporation of this and other isotopes into compounds involved in cyclic metabolic chains, reveals problems of deficiencies, abnormal rates, and improper balances in complex biologic systems. The ability of cells to replicate critical components, their rates of cell division

under different conditions of disease, and their abilities to repair and regenerate subsequent to damage of various kinds, are types of studies that will be emphasized.

Experiments designed to influence the course of disease by unique applications of radiation will be continued, especially in those situations where the disease presents a ready made opportunity for experimental study. Carbohydrate metabolism in the diabetic human and in experimental animals is an example. Such metabolism is closely related to protein and fat metabolism in various tissues and may be influenced or controlled by the nervous and endocrine systems. Continuing analytical investigations will provide increasingly critical data, which in turn will enable more effective treatment of disease.

Carbon 14 labeled fatty acids and colesterol have been administered to animals in the study of developing lipoid materials found in the arterial plaques associated with atherosclerosis. Furthermore, the physicochemical characterization of fatty macromoleucules have been studied in relation to other metabolic diseases, including the chronic effects of radiation on lipoprotein metabolism. Results to date indicate that this work is very promising and will be expanded slightly in 1961.

The utility and value of fresh whole blood, blood platelet preparations, and lyophilized platelets for the treatment of blood diseases in which bleeding occurs has been under investigation in relation to various clinical diseases for several years. Progress has been made and remaining potentialities appear significant. Studies in this area will be continued by using more advanced labeling techniques for different kinds of cells. Such studies are expected to provide a more complete understanding of occurrences when different cell types are transfused—that is, how they survive, function and multiply in relation to host cells. Carbon 14 labeling will be the basis for continuing research in metabolic diseases just as iron 59 labeling of hemoglobin has been and continues to be the foundation for studies of diseases that affect red blood formation.

Tritium labeled "thymidine" also has been found especially valuable in studies of the origin, function, migration, proliferative rate and survival of different types of blood cells, and also other cells. Additional research in fiscal year 1961 is expected to extend the application of these useful analytical procedures to a further understanding of basic biological processes.

(c) Biological research:

Fiscal year 1959	$2,958,414
Fiscal year 1960	3,275,000
Fiscal year 1961	3,440,000

Research in this activity is designed to exploit as fully as possible the beneficial applications of rediation and radioactive isotopes in the fields of biology and agriculture. Rarioactive isotopes represent some of the most powerful tools developed by sicence for the study and elucidation of the incredibly complex process and reactions upon which life is based. Isotope techniques permit a better understanding of many agricultural problems, and such an understanding results in improving the nutritional status of the world's population.

The recognized and vitally important role of the Atomic Energy Commission in fundamental studies on the application of tracer and radiation techniques in agriculture is resulting in valuable information for general application. Areas of research in which continued efforts are planned are farm animal nutrition and metabolism, invertebrate parasites of farm animals, insect biochemistry and physiology, and studies of the basic aspects of soil chemistry. Workers in plant physiology, biochemistry and genetics have rapidly adapted isotope techniques to their research. Such an application has not taken place in the field of plant pathology; therefore some expansion of this area of research will be pursued. Studies on plant metabolism and radiation genetics will be expanded to include further work on tropical forms because of the necessity of increasing agricultural productivity in most of the areas where such plants are raised. Finally research will be continued on the physiological genetics of higher plants in order to develop more useful plant varieties; varieties that would, for example, discriminate better against fission products in the soil. Plants that would scavenge fission products selectively could be used to remove the excess radioactivity following heavy fallout.

Considerably more information is required on the structure, synethesis, and control of synthesis of large molecules of biological importance, such as proteins and nucleic acids. It appears certain from recent experimental evidence that radiation-produced mutations do not become "fixed" immediately except

under rather specific conditions. Thus it appears that the "fixation" occurs only if the cell is actively growing and synthesizing protein and nucleic acids. The mechanisms of protein, ribonucleic acid and deoxyribonucleic acid biosynthesis, a determination of their structures and functions and particularly the interrelations between them are essential to the understanding of radiation damage both from a genetic and a nongenetic standpoint. This program will be continued to permit an early understanding of the interrelationships of ribonucleic acid, deoxyribonucleic acid, and protein metabolism as they are related to gene mutation and other damages resulting from ionizing radiations.

Studies on the basic mechanisms of energy absorption, conversion, storage, and transport in photosynthesis and other photochemical processes in biological and model systems provided information useful for the interpretation of the similar, but little understood processes involving ionizing radiation. Studies of the fundamental biochemistry and physiology of living material using radiation and radioactive tracer techniques are dependent upon a considerably better understanding of the chemistry and physiology of normal living cells and organisms which will establish in detail (*a*) the mechanisms of ioninzing radiation injury and (*b*) rational approaches to the prevention and alleviation of damage from ionizing radiation. These studies will be continued in fiscal year 1961.

A program is being initiated to demonstrate the feasibility, acceptability, wholesomeness and safety of low level radiation processed foods to extend the shelf life of selected perishable foods. The AEC program will be concerned only with substerilizing levels of radiation (less than 1 million rads) and will not duplicate work by the Department of the Army. Preliminary work will include collection and analysis of applicable data and undertaking appropriate studies in food chemistry, microbiology, and wholesomeness.

(*d*) Environmental sciences:

Fiscal year 1959	$407,350
Fiscal year 1960	502,000
Fiscal year 1961	509,000

During fiscal year 1961 ecological research in this activity will be further directed toward the development of appropriate techniques for studies of the dynamics of exchange of minerals in a growing community of plants and animals.

Further determination will be made of the importance of iron, calcium, phosphorus, zinc, cesium, strontium, sulfur, and other elements in regulating the quantity of food produced in fresh water and in oceans and of the role of these elements in limiting such production. Information will be sought concerning the uptake of phosphorus 32 by various populations of organisms and the retention time for this isotope. Further elaboration of the fate of various isotopes in water will be explored during this fiscal year. Research will be supported to develop various techniques of the utilization of radioactive elements to solve ecological problems such as the concentration of trace elements and their role in the life of various organisms. The dynamic of production in idle lands, in lakes of low productivity and in the oceans will be studied. Microclimatic studies will be continued to develop a better understanding of the limits of existence of local communities of biota.

Certain field experiments to determine some basic facts such as rates of diffusion in standing water and the rates of flocculation and sedimentation of biologically important radiochemicals, will be performed during fiscal year 1961. The migration patterns of a few economically important organisms will be studied by isotope tagging under controlled conditions. Some expansion of effort will be devoted to the development of techniques for using radioisotopes for tagging or for other methods of identifying individual organisms and populations in studies of ecosystems.

The potential production of large quantities of algae, which may be given as food for yeast and which in turn may be eaten by man, will be under investigation in some laboratories using carbon 14 as a tool. Comparisons will be possible between quantities of organisms, their length of life and similar problems with carbon 14 techniques, which techniques are being studied for further refinements.

e. Distribution of radioisotopes under research support program:

Fiscal year 1959	$303,661
Fiscal year 1960	330,000
Fiscal year 1961	330,000

Fiscal year 1961 will be the sixth year of providing radioisotopes to research institutions for approved projects in the fields of medicine, biology, and agriculture at an 80 percent reduction from Atomic Energy Commission established prices. Three factors could normally be expected to increase the overall cost of the radioisotope research support program: (1) the introduction of new products, e.g. iodine 130, cadmium 109; (2) new participants in the program; and (3) increased purchase volume of certain isotopes. However, recent price reductions in the price of iodine 131 and carbon 14 will serve to offset the overall increase. It is estimated that the increased participation and price savings will counterbalance, therefore no significant change in level of the program is anticipated during fiscal year 1960 and fiscal year 1961.

4. Biomedical problems in atomic energy operations, $14,398,000

(*a*) Medical research:

Fiscal year 1959	$2,204,591
Fiscal year 1960	2,675,000
Fiscal year 1961	2,795,000

Atomic energy operations are not only faced with hazards from external radiation sources but with numerous other potentially hazardous agents which may be deposited within the body and are therefore classified as internal radiation hazards. These cannot be dealt with by the expediency of shield construction but require prophylactic methods of inceptive hazard removal and actual removal from the body by chemical agents. Many of these hazards are associated with the mining, milling, and concentration operations encountered in the procurement of raw materials and ores and in the purification, fabrication, and reprocessing operations found in the manufacture of nuclear weapons and fuels. Research must be expanded to evaluate these hazards, to set tolerance limits and to develop protective and/or corrective methods to control or neutralize hazards. This information is being disseminated to the Division of Licensing and Regulation, the Division of Reactor Development and to Atomic Energy Commission contractors as well as other interested Government and non-Government organizations as rapidly as the research data become available.

An expanded program of investigation is planned for fiscal year 1961 relative to the potential hazards from fission product contamination resulting from reactor operations and a contaminating reactor accident. Not only are studies necessary on the hazards of radiotoxic elements connected with reactor operations, but similar studies must likewise be made to determine the toxicity of many nonradioactive elements now coming into prominence as components of reactor development and construction. Elements which were no more than laboratory curiosities a few years ago are now being found to meet special requirements such as withstanding high temperatures and pressures in intense radiation fields for long periods of time without corrosion or other metallurgical damage. The acquisition of toxicity data must parallel the development on the technological effectiveness of the material. It is for these reasons that rsearch in the following areas will be expanded in fiscal 1961:

(1) An extensive screening followed by indicated acute and chronic toxicity studies on such elements as promethium, scandium, niobium, and europium, together with various alloys.

(2) A systematic study of the inhalation toxicity of the rare earth elements, including cerium, lanthanum, neodymium, and praesodymium.

(3) A continuing study of the effect on the lungs and other organs of inhaled and nonradioactive particulates, particularly in relation to the possible production of lung cancer.

(4) The establishment of several low-level counting facilities which will be strategically located in areas of uranium mining and production operations. These are planned to be used for monitoring uranium workers as well as being available for the investigation of industrial medical problems in cooperation with State public health agencies and medical schools.

(5) A program designed to study the inhalation, retention, and metabolism of mixed fission products which may be released as the result of certain types of reactor failures, the operation of different types of airborne reactors and the composition of various types of SNAP projects, in collaboration with the Division of Reactor Development.

(6) Long-term followup studies of chronic beryllium and mercury exposure cases.

(*b*) Biological research:

Fiscal year 1959	$2,224,741
Fiscal year 1960	2,542,000
Fiscal year 1961	2,785,000

Biological research in this category deals with fundamental reactions in plant and animal systems resulting from various fission products arising from atomic energy operations. These studies continue to assume great importance with reference to increasing development of reactor powered vehicles and installations and consequent hazards of possible contamination of the environment with fission byproducts. Special emphasis will be directed toward studies concerning acute and chronic effects resulting from assimilation of fission products in soil and plant systems, and in animals resulting from ingestion of fission products through the food chain. Controlled studies utilizing small animals will be continued at approximately present rates; however, the use of larger animals, especially farm animals, will be greatly expanded. The larger farm animals are important factors in the food chain for man.

In addition to an expansion of studies concerning absorption, distribution, retention, and excretion of fission products in animals, attention will be directed toward studies employing chelating agents and other methods to alter absorption, distribution, and retention of radionuclides. Research concerning physical and chemical treatments of soils to reduce the availability of fission products to food crops and investigation of plants which might be utilized to reduce soil contamination will be continued.

(*c*) Biophysics research:

Fiscal year 1959	$1,188,147
Fiscal year 1960	1,446,000
Fiscal year 1961	1,816,000

The biophysics research program is concerned primarily with (1) health physics related to potential radiological hazards in and around plant and laboratory areas; (2) earth sciences as they relate to the disposal of radioactive wastes; and (3) dosimetric studies of maximum permissible body burdens and maximum permissible concentrations of radionuclides in air, water, or food. Studies of the physical, chemical, and biochemical behavior of radioactive substances and toxic chemicals released to the environment by normal operations of Atomic Energy Commission installations will be continued.

A problem of fundamental importance is to provide low-level chemical and radiological methods for the determination of radioisotopes in waste streams, materials of the environment and biological fluids. These data provide the bases for radiological protection. Analytical procedures for transuranium elements in environmental materials will be studied for suitability for routine analyses.

Additional studies will be directed toward the disposal of intermediate and low activity liquid and solid wastes, particularly at Oak Ridge and Hanford. Most fission products exist as cations in aqueous wastes and can therefore be removed from solution by soil materials through which they pass. Therefore, the physics and chemistry of soil disposal will be studied in order to take advantage of this capacity for removing radioactive cations.

Studies of maximum permissible body burdens and maximum permissible concentrations of radionuclides have been developed in conjunction with the Internal Dose Committee of the National and International Committees on Radiation Protection. These values are needed as guides for designing reactors, processing radioactive materials, and other developments in the use of atomic energy. In addition, maximum permissible concentration values are needed for questions related to the general population such as effects of fallout, and discharge of radioactive effluents into the atmosphere and into water systems. The program for fiscal year 1961 includes the following: (1) analysis of human tissue for certain elements using the methods of emission spectrography and flame photometry, (2) analysis of human diets and excreta from metabolic balance studies, (3) collection and evaluation of biological and physical parameters useful in obtaining values of maximum permissible body burdens and maximum permissible concentrations of radionuclides, (4) obtaining data applicable to the determination of gonadal dose, and (5) studying the

gastrointestinal tract histologically and autoradiographically for damage, specially by alpha emitters.

Special industrial hygiene and health physics surveys will continue to be performed by the health and safety laboratory. Emphasis will be placed on fuel element fabricating facilities, mill facilities, reactor sites, and large accelerators. These surveys will be supplemented by studies leading to standards of controls and by development of adequate sampling, counting, and analytical procedures and equipment.

(*d*) Environmental sciences:

Fiscal year 1959	$3,637,897
Fiscal year 1960	5,786,000
Fiscal year 1961	7,002,000

The program of worldwide monitoring of the land, sea, and air will be expanded with more emphasis on (1) developing a balanced sampling network, utilizing improved techniques, for documentation of long-term changes and (2) cooperating with other Federal and State agencies in developing a more adequate capability for investigating local distribution and variations of environmental radiation. The curtailment of Department of Defense upper atmospheric monitoring projects (Grab Bag and HASP) will result in an increase in cost to the Atomic Energy Commission for sample collection by balloon and aircraft.

With the increase in the quantity and quality of monitoring data available, more intensive research studies will be supported on the dependence of worldwide distribution and isotopic composition of fallout on the latitude, altitude, yield, and nature of nuclear detonations. Research will be expanded on atmospheric transport and scavenging processes, latitudinal banding of fallout, and "hot spots." Further development and testing of sampling devices and analytical techniques will be undertaken in order to extend the geographical and altitude coverage and sensitivity of detection of radioactive contamination. Increasing use will be made of the scientific information developed in the monitoring program to estimate the environmental contamination which can be expected from nuclear powered space vehicles.

Studies of meteorological conditions in the vicinity of major Atomic Energy Commission facilities, tracer studies of the dilution of stack effluents in the atmosphere, and basic studies of turbulent diffusion will be continued at the same level as in fiscal year 1960.

Research projects in ecology are expanding in number and in scope as the utilization of atomic energy increases, and as developments produce potential contaminants for the environment. The cooling of reactors and of nuclear processing plants results in the release of small quantities of radioisotopes into the environment. A careful study of the organisms in the environment of nuclear facilities will be made to locate possible concentration of elements and to interpret the effects of any accidental release of radioactive materials.

Many of the radioelements from fallout and other sources that appear on land and fresh water will dissolve in running water and join the 70 percent of the fallout isotopes that originally come down in the ocean. A substantial research program in the marine sciences will be supported in fiscal year 1961 to advance present knowledge of this contamination. The potential distribution of radioactivity from failure of propulsion units or accidents to nuclear submarines, nuclear airplanes, and nuclear missiles will also be studied.

Investigations will continue of ocean currents and of the immediate and ultimate distribution of radioactivity by plants, animals, and sediments in the ocean. Background levels of radioactivity are being determined in order to provide baselines for studies of the effects of operations of nuclear ships and other devices on life in the sea. Since the oceans contain a substantial amount of radioactive potassium, radium, thorium and other radiochemicals, research on the relationship between normal and added radioactivity will continue to be supported.

Studies will be continued of the capacity of the environment to accept radioelements without adverse effect and of the factors that contribute to this acceptance. Investigations will be expanded to assess the genetic and physiological effects of radiation from Atomic Energy Commission facilities and from the use of nuclear devices to relieve such cultural problems as power production and mass excavation of harbors and channels. An expanded program is needed in

order to meet special problems concerned with peacetime applications of nuclear devices.

Studies will be expanded of the long-range effects of radiation on the environment of Commission installations. Studies of special problems of toxicity of radiochemicals to various species of organisms will receive additional support at Hanford, Oak Ridge, and other sites.

5. Dosimetry and instrumentation, $2,927,000

(*a*) Dosimetry:	
Fiscal year 1959	$539,915
Fiscal year 1960	622,000
Fiscal year 1961	738,000
(*b*) Instrumentation:	
Fiscal year 1959	1,653,623
Fiscal year 1960	1,980,000
Fiscal year 1961	2,189,000

The control of nuclear radiation hazards and quantitative experimental biomedical research are both dependent on the development of measurement systems and instrumental equipment. The program of dosimetry and instrumentation has a twofold approach directed to the implementation of both radiation control and radiation research in biology and medicine. These are: (1) Special application of existing techniques to the many varied radiation hazard situations and to research experiments, and (2) a basic study aimed toward the discovery of new fundamental techniques for detecting each of the significant forms of nuclear radiations and development of these new techniques as useful instruments. The increased emphasis on biomedical research particularly as it relates to radiation protection requires expansion of the development of instrumentation in the following areas in fiscal year 1961:

(1) Special problems in radiation protection arising from the varied operational environments throughout the Commission's plants and laboratories require a slight expansion of instrument developments. Particular emphasis will be directed toward the development of radiation measurement techniques and equipment associated with the control of hazards arising from the new high energy accelerators in use or under construction. The application of transistor circuitry to radiation instrumenation is expected to improve reliability, serviceability, and operational life of the equipment.

(2) Low level radiation detecting and counting equipment is becoming increasingly more important. The effort in this area will be directed in two phases: (*a*) The measurement and evaluation of external radiation at the natural terrestrial and cosmic ray backgrounds including quantitative measurement of the slight increases caused by fallout, and (*b*) the measurement of low level radioactivity in humans and foods, both natural and bomb yield.

(3) Recent problems arising in biomedical research on the effects of alpha, beta, gamma, and neutron radiations, both individually and mixed, at the organ and cell levels require an expansion of dosimetric instrumentation. Specific emphasis will be directed toward the development of instruments for measuring the energy transfer from the irradiating particles to the cells along their path in order to study the mechanism of cell damage. Instrumentation to delineate the relative dose contribution in mixed gamma, slow and fast neutron fields, will continue at an increased rate.

(4) Further research will be directed to the development of instruments for clinical and research applications. This will include development of an improved medical scanning spectrometer for localizing radioactivity used in diagnostic and therapeutic techniques; also a continuing development on small in vivo detectors to pinpoint beta emitters used as diagnostic tracers.

(5) A significant new area of research is that of instrumentations for obtaining images of nuclear tracks in scintillation detectors. The technique requires development of special high gain image intensifier electronic tubes in which an image at exceedingly minute light levels is amplified sufficiently to be seen or photographed. This technique will provide researchers with a capability of

studying the behavior of single nuclear radiation tracks. Development of these tubes will continue at an accelerated rate.

6. Nuclear energy civil effects program

Fiscal year 1959	$1,226,566
Fiscal year 1960	1,400,000
Fiscal year 1961	1,035,000

The civil effects program is designed to utilize unique facilities and competencies within AEC to obtain information and data needed to fulfill AEC's responsibilities for protection of its operating personnel against effects of nuclear explosions and to make available information on atomic energy needed for overall national planning for nonmilitary defense. The suspension of tests has not decreased the need for these data which has followed and closely paralleled the advances in weapons development. Emphasis is now being placed on obtaining information by conducting field experiments not requiring nuclear explosions, more extensive use of laboratory studies, and correlation of results with data from previous nuclear tests and Atomic Bomb Casualty Commission medical data on Japanese survivors of Hiroshima and Nagasaki.

In fiscal year 1961, the program will emphasize continued aerial radiological monitoring survey of reactor and other AEC nuclear sites to obtain baseline radiation measurements and maintain readiness capability for rapid aerial radiological survey of any areas where significant radiation may be released. Studies of fallout, decontamination, and shielding of existing structures, shelters, and topography using radiation sources to simulate fallout will continue, as will the AEC community civil defense project begun in Oak Ridge during 1959. Laboratory and field studies of prompt neutron and gamma radiation shielding from simulated weapons effects will be further correlated with medical and shielding data being developed in Japan by ABCC; this is related to the reexamination, evaluation, and correlation of data on blast and thermal effects from weapons tests, laboratory, and other field studies, with medical and radiation data associated with selected Japanese survivors.

Further studies will be undertaken in the field and laboratory on acceptable biological criteria for shelter environment including studies of controlling blast, thermal, and radiation parameters. A modest capability will be maintained to undertake effects studies should weapons tests be resumed. Support of Division of Biology and Medicine research projects at Nevada test site will be continued. Technical information for practical applications in defense against nuclear explosions and to maintain current technological evaluation of probable future overall developments in weapons and delivery systems as they bear on civil effects problems of individual, group, and national survival will be prepared and disseminated.

7. Equipment not included in construction projects, $2,188,000

Effective conduct of biomedical research programs requires acquisition and replacement of equipment in Commission and university laboratories, totaling $2,188,000 in fiscal year 1961, an increase of $232,000 over fiscal year 1960. The necessity of measuring continuously decreasing levels of radiation and its effects at the cellular level at extremely short time intervals means that new technical developments for sensitive and elaborate electronic and other laboratory and shop equipment must be exploited. In addition to the normal requirements for equipment, the following major items will be provided in fiscal year 1961:

(*a*) A paramagnetic resonance spectrometer for the measurement of energy transfer in biological systems is planned for Argonne National Laboratory.

(*b*) A plutonium counter will be provided for use in the total body counter at Hanford.

(*c*) A machine for X-irradiation in the biological research program and nuclear resonance equipment for the medical research program at Brookhaven National Laboratory will be provided.

(*d*) A scanning microspectrophotometer and recording spectrophotometer are planned for Oak Ridge National Laboratory.

(*e*) Several additional whole body counters will be placed in laboratories conducting research of programmatic interest to the Commission. Additional research in bioenergetics at offsite university laboratories will also result in increased equipment costs.

The following tabulation indicates the amounts estimated for equipment compared to the other operating costs at each major installation.

Installation	(In thousands)	
	Other operating costs	Equipment costs
Argonne Cancer Research Hospital	$2,140	$60
Argonne National Laboratory	4,394	230
Atomic Bomb Casualty Commission	2,000	100
Brookhaven National Laboratory	4,845	300
General Electric Co., Hanford	2,372	100
Health and Safety Laboratory, New York	1,822	80
Lawrence Radiation Laboratory	2,375	125
Oak Ridge Institute of Nuclear Studies	1,080	90
Oak Ridge National Laboratory	5,583	320
University of California at Los Angeles	1,715	85
University of Rochester	1,726	74
All other	21,960	624
Total	52,012	2,188

Mr. RABAUT. What significant advances have been made in research on this program since last year?

ADVANCE IN PROGRAM

Dr. DUNHAM. Yes. Generally, the programs have advanced very nicely. Specifically, you will recall that last year I told you that some of the genetic studies at Oak Ridge indicated that low-dose-rate radiation had a lesser genetic effect than had been previously supposed. I am now happy to tell you that Dr. Muller, who is one of our country's outstanding geneticists and who has been working with people at Brookhaven, has shown this also to be true in the fruitfly. This means that it probably is a general phenomena, that the genetic effects of radiation in occupational types of exposure from fallout are probably less than had been thought.

Mr. RABAUT. Is there any degree of less less, or whatever we want to call it?

Dr. DUNHAM. By a factor of four, about one-fourth. There is some interesting work at Brookhaven on the rate of growth of cancer cells. We can now measure that using radioisotopes to label certain of the substances which are incorporated in a cell. We have found that certain tumor cells grow much more slowly than had been thought. It had been thought that all tumor cells grew unusually rapidly. It turns out that this is not the case. It is not a helpful finding, in that it probably makes the problem of using chemicals to treat cancer, or even radiation, a more difficult one with the very slow growing tumors, because it is only in certain phases of the growth cycle that they are particularly sensitive to these agents, but it is a very important observation.

Mr. RABAUT. It was not known before?

Dr. DUNHAM. That is correct.

Mr. RABAUT. Can you report on anything else?

Dr. DUNHAM. At the Argonne Cancer Hosiptal they are using a material very similar to thyroxin which seems to increase the sensitivity of tumors to radiation therapy. This should be a favorable thing in terms of treating cancer.

I could name a number of others, but maybe I had better stop at this point, sir.

Mr. RABAUT. In your testimony you might enlarge on it a little.

Dr. DUNHAM. Fine.

Mr. RABAUT. Please review the activity increases making up the total increase of $5.2 million.

Dr. DUNHAM. I would say, first, that half of that roughly is plain cost of living. The costs are more to do scientific research this coming fiscal year than in the past.

The Cancer Society has estimated that it is roughly 6 percent in increased cost to do the same amount of research. You see, our total increase is 11 percent.

Mr. RABAUT. Five percent of the total is for cost increase?

Dr. DUNHAM. Eleven percent is the increase we have asked for. About half of that is simply cost of living.

Mr. RABAUT. What is the other half?

Dr. DUNHAM. The other half is for several areas, probably the most important of which is the thing I mentioned last year, that we are intensifying our efforts to understand the transfer of energy between molecules in an effort to get at the more fundamental mechanisms of radiation effects. About a half million dollars goes for that.

We are developing an increased——

Mr. RABAUT. Are you meeting with any success in your studies?

Dr. DUNHAM. This is just getting underway. We have been able to establish at the Florida State University a major project. The university is putting up a building and we are supporting research that will be going into that building.

Also, we have made arrangements with the University of Minnesota for training people in this particular technique of approaching radiobiological problems. So the thing is moving.

The swine irradiation project at Iowa State is just getting underway, and will cost an extra $100,000 next year. Up until now the moneys have been spent largely for construction of facilities.

The problem of inhalation of fission products is becoming a more important one. Some of the observations made on Mr. Kelly, the individual who died at Los Alamos 2 years ago, suggests that we need much more information here. We are increasing that effort to the extent of about $300,000.

We also are increasing our effort in the marine sciences; that is the study of the uptake and movement of fission products and nuclear debris in lakes, rivers, and oceans.

Mr. RABAUT. Do you mean the effect of disposal of wastes?

Dr. DUNHAM. That is one reason. One reason for the work is the problem of disposing of low-level waste in the ocean. But perhaps the more important one is the fact that we are developing nuclear submarines and nuclear ships. There might be an accident some day. We have the SNAP devices which may come down in the ocean. We must know more about what happens if a large amount of fission products is released.

Mr. FLOBERG. We also have the problem of nuclear depth charges.

FALLOUT STUDY

Dr. DUNHAM. That is right. The other area is in the continuing fallout study program, about $900,000. Right now we are in a position to learn more than we ever learned in the past because there are no important weapon test activities going on.

Mr. RABAUT. Does that recitation take care of the total increase?

Dr. DUNHAM. That takes care—no—that takes care of the real increase, yes; as opposed to the cost-of-living factor.

Mr. RABAUT. The cost of living is half of it?

Dr. DUNHAM. Yes.

COOPERATION WITH HEW

Mr. RABAUT. Now, Dr. Dunham, last year we had some discussion concerning the cooperation between the Department of Health, Education, and Welfare and the AEC on matters involving public health. What further has been done in that respect?

Dr. DUNHAM. We continue to cooperate with them. Last fall we entered into a joint project with the Department of Agriculture and the HEW in the removal of strontium 90 from milk, using the Department of Agriculture's pilot milk plants. We have been jointly supporting studies on the uptake of strontium 90 in human bones. We have worked very closely with them in the development of their budget for 1961. Dr. Weber and I sat down and spent quite a little time going over our budgets to assure that there would be no overlap or duplication, that we would work jointly.

Mr. RABAUT. Did you get involved in the cranberry situation?

Dr. DUNHAM. No, sir, thank you. I sympathize with the people who did because it is somewhat the same problem that we have with radiation.

Mr. RABAUT. The environmental sciences program as shown on page 196 has been increased from $1,637,145 in 1958 to $7,020,000 in 1961. This program has to do with checking contamination in the atmosphere. How can this program be so increasingly important or necessary with the discontinuance of atmosphere testing programs?

PROGRAM OF ENVIRONMENTAL SCIENCES

Dr. DUNHAM. First, this program is not solely concerned with checking the contamination of the atmosphere. This program of environmental sciences includes the study of the movement of fission products, radioactive contaminants in the air, in the soil and into the food chain. It is a very broad program. It also includes as a part of that, peaceful uses of nuclear energy, that is studies in the field of radio ecology.

Mr. RABAUT. How much have you spent up to date?

Dr. DURHAM. Well, at the end of this fiscal year we will have spent practically our entire allotment of $49 million.

Mr. RABAUT. You are talking about the whole program?

Dr. DUNHAM. Yes; including this figure in the environmental science.

Mr. RABAUT. This figure has increased from $1.6 million in 1958 to about $5.8 million this year. How much have you spent on this item for this year?

Dr. DUNHAM. We have spent a little over $5 million so far.

Mr. RABAUT. From 1958 this figure has gone up from $1,637,000 plus to the request for 1961 of $7.2 million.

Dr. DUNHAM. That is correct.

Mr. RABAUT. Have you enlarged the program?

Dr. DUNHAM. Yes. We have enlarged it very greatly. The program was started in about 1956 or 1957. It also includes the expanded fallout studies program which was greatly expanded in the last couple of years.

Mr. RABAUT. It does more than I thought it did when I questioned about the contamination of the atmosphere.

Dr. DUNHAM. That is correct.

Mr. RABAUT. It goes even down to food; is that correct?

Dr. DUNHAM. That is correct.

Mr. RABAUT. Are there any questions on this biology and medicine program, $54.2 million?

Mr. JENSEN. Dr. Dunham, what would you say is the most important finding of your branch of the Atomic Energy Commission up to date in the field of finding the causes and cure of cancer and other human dread diseases?

USE OF LARGE CYCLOTRON FOR BLOODLESS SURGERY

Dr. DUNHAM. During the past year—I will not repeat what Dr. Lawrence said—this is an extremely important development, using the large cyclotron for bloodless surgery. I mentioned before you came in that we have found some things about the rate of growth of tumor cells which are of extreme importance in terms of treatment. They probably are not favorable and they explain some of the treatment failures. Tumor cells do not grow as fast as had been previously thought. At the University of Rochester they have been developing an antibody type of material which is loaded with radioiodine, and which is introduced into rats with a certain type of cancer; they can cure about two-thirds of those rats, and destroy the cancer.

Mr. JENSEN. In what stage?

Dr. DUNHAM. A well-established tumor. They are just beginning to try it out on patients at the Strong Memorial Hospital.

RELATIONSHIP OF CANCER AND TUMOR

Mr. JENSEN. You speak of cancer and you speak of tumor. Will you explain the relationship, if any, between tumor and cancer?

Dr. DUNHAM. Tumor is a much broader word, sir. Any swelling or enlargement is a tumor. A bump on the head produces a tumor. I should not use that word, because I am talking specifically about cancer.

Mr. JENSEN. Could that develop into cancer?

Dr. DUNHAM. It is very rare that a thing of that sort will develop into cancer.

Mr. JENSEN. But a tumor can develop into cancerous condition?

Dr. DUNHAM. That is correct. Many a cancer begins with what appears to be a perfectly benign tumor. After a number of years they go, as we say, malignant, begin to grow wildly.

Mr. JENSEN. While in the tumor stage your treatment is more effective than when it gets into the cancer stage?

Dr. DUNHAM. When it is a discrete tumor, with a capsule around it, which is the case with benign tumors, it can be treated a number of ways. It can be treated with radiation or a surgeon can go in and cut it out simply and neatly with a knife. When it begins to spread is when the problem arises.

Mr. JENSEN. At what stage of the cancerous condition does the radioactive isotope treatment have no effect or little effect, as a cure or arresting the cancerous condition?

Dr. DUNHAM. Unless we are using radioisotopes as radio cobalt in place of an X-ray machine to treat cancer, the value of using isotopes is directly proportional to how much of that isotope you can get into the tumor. Now, in general the more a tumor cell behaves like a normal thyroid cell, with the result that a thyroid cancer can still take up radioactive iodine in the same way as a normal bit of thyroid tissue, then large quantities of radioiodine are taken up and that is how occasionally a case of thyroid cancer is cured. There are a number of efforts being made now to try to make the tumor cell behave more like the normal cell from which it sprang so that it will behave this way. That is another indirect approach to improving treatment of cancer.

Mr. JENSEN. After the location of a cancerous tissue is discovered, then you attack that cancerous area by your radioactive ray. Then what takes place? The ray then destroys the germ which creates the cancer?

Dr. DUNHAM. That destroys the cancer cell. The trick is to destroy the cancer cells without destroying normal tissue which is surrounding that cell.

Mr. JENSEN. Your radioactive ray dissolves the cancer cell to nothing, to zero?

Dr. DUNHAM. It just plain kills it as if you hit it with a hammer.

Mr. JENSEN. Then you can eliminate the cancerous condition if it is not in the last stages where that ray from your isotope has no effect on the diseased area?

Dr. DUNHAM. Well, it is relative to the effect on the normal area. The difference is not great enough so that you can no longer give the radiation without doing more damage than the patient can stand.

Mr. JENSEN. Now, Dr. Lawrence explained to me when I was at the laboratory in Berkeley that at that time they had treated 132 patients in all different stages of cancer. They had arrested the cancer in a number of cases to the end that the people are now again quite active.

Dr. DUNHAM. Yes.

Mr. JENSEN. In fact, I saw that Mrs. Davis, 72 years old, and she is getting along fine. The doctor said she was. Of course, your treatment, as I understand it, has harmed no one. Is that correct?

Dr. DUNHAM. That is correct. We do not treat the cancer directly. What you do is destroy the pituitary gland. It is a bloodless form of

surgery. This treatment has been done with surgery previously but it is a dangerous operation. It is an operation which takes place right near where the optic nerves are, and occasionally blindness may result. They have had no blindness in their patients.

Mr. JENSEN. And they have arrested a blindness condition that was being aggravated by this treatment. They have stopped the blindness from becoming more severe.

Dr. DUNHAM. Yes.

Mr. JENSEN. I hope and pray that the time will come, and soon, when this treatment will be more effective than it is today, and I believe that time is not far away. I have become thoroughly convinced after I visited the laboratory at Berkeley and talked to Dr. Lawrence and that wonderful staff which he has. They are the most dedicated people I have ever known, they live that day in and day out. Mrs. Davis walked down those steps as spry as a cricket, 72 years old. She said, "I am supposed to be dead. Look at me now." I just don't have the words of praise that would be appropriate or sufficient to express my feelings about Dr. Lawrence and the work that he and his staff does. I just hope you will continue with this great humanitarian effort and that it won't be long until we have licked it, along with the great scientists in medicine and surgery all over the world, that are working in complete harmony with you, giving you all the knowledge that they have, and you are giving them all the knowledge that you have.

Dr. DUNHAM. Absolutely.

Mr. JENSEN. Thank you, Doctor.

Mr. RABAUT. The gentleman from New York.

Mr. PILLION. Doctor, X-rays have been used for cancer for a great many years, is that right?

Dr. DUNHAM. Yes.

Mr. PILLION. And the X-ray effect is a good deal like the radium effect.

Dr. DUNHAM. It is pretty much the same.

Mr. PILLION. As the type of work you are doing here and investigating, is that correct?

Dr. DUNHAM. That is correct.

Mr. PILLION. Radium and X-rays were used a long, long time before the Atomic Energy Commission was ever established, is that right?

Dr. DUNHAM. That is right.

Mr. PILLION. And many hospitals that have treated tens of thousands of patients with radium needles and X-rays and so forth have found that this is not a very hopeful avenue for a cure of cancer. Is that correct?

Dr. DUNHAM. It is probably not the ultimate answer to cancer treatment.

Mr. PILLION. It is not successful as an ordinary cure for cancer, is it?

Dr. DUNHAM. That is correct.

Mr. PILLION. Once cancer begins to spread in the body a radium needle or any of your various types of things you are studying here are not a cure, are they?

USE OF ISOTOPES IN CANCER THERAPY

Dr. DUNHAM. This is not quite the case. In fact, this is where isotopes are helpful because you can, to a certain extent, direct an isotope toward the tumor in a way that you are unable to do with an X-ray beam without involving a lot of normal tissue. That is how we treat cancer of the thyroid with radioiodine. The cancer picks up the iodine, the rest of the cells don't pick it up at all. The group at Brookhaven are particularly interested in this field that they call electroradiation, steering a radioisotope to a particular cell type. This I think has a great deal of hope.

Mr. PILLION. You say that has been successful in some cases?

Dr. DUNHAM. In a small way to date, but I think there is a lot more progress that can be made in that direction.

Mr. PILLION. Is that the major development that we have had that has a practical application in all the sums that we have appropriated here and all the studies that have been made under the direction of the Atomic Energy Commission?

EFFECTS OF RADIATION

Dr. DUNHAM. No; I would not say that, sir. Our broader program, which is to define and to alter the effects of radiation on normal people, and which includes the problem of radiation hazards in industry and the like, is where our main effort is and this is where we are making progress each year.

Mr. PILLION. Now, exactly what have we applied to industry that we have learned from all our studies? Exactly to what practical application have we put any of this knoweldge in any plant?

Dr. DUNHAM. These particular observations would be applicable all plants or all activities dealing with radiation. What we are trying to do is to determine whether there is any effect from exposures to radiation low dose rates, not like an atomic bomb or an X-ray machine, but the kind people get when they work in the industry. The more we look at these low dose rates, the less the effect seems to be. This is a very encouraging thing and will permit us to place the radiation standards on a much firmer basis.

Mr. PILLION. How many people in the whole country work in an area where they are exposed to any great extent to these things we are trying to avoid?

Dr. DUNHAM. There are thousands of X-ray machines in doctors' offices. Each one of those exposes people to it. Not the patients. I am talking about the people who run the machines. In the atomic energy industry, I don't recall the exact figure, it is either 50,000 or 60,000 who are working with radiation every day.

Mr. PILLION. I know, but I have not read of many technicians dying from overexposure to X-rays and I have read of no unusual precautions other than they find themselves that would cut down terrifically the death rate or the lifespan of doctors or technicians who work with X-rays. I don't consider that a problem worth millions of dollars for continuous studies.

Dr. DUNHAM. That is correct.

Mr. PILLION. What I am trying to get at is some concrete avenue, something that is especially practical that we can benefit humankind by reason of the funds that we are pouring into this program.

AGRICULTURAL APPLICATIONS

Dr. DUNHAM. Well, maybe we can skip over to some of the agricultural applications. I am not talking about wheat. I am talking about something like peaches, where the Brookhaven people, in conjunction with an agricultural experiment station, have developed a freestone-peach variety that fruits a week or two ahead of the normal. They are developing one that fruits a couple of weeks later. That extends the peach market over a longer period of time.

Mr. PILLION. I have grown them early and late, as late as October and as early as June and July, and I can't see the value of spending hundreds of millions of dollars for that sort of thing. I conclude right there, Mr. Chairman. I got that off my chest.

Mr. JENSEN. Let me say this. I am quite sure, Mr. Pillion, if you had been with me at that laboratory at Berkeley, of which Dr. John Lawrence is the head, and had seen all of the equipment that is necessary to create these isotopes that are used in medicine and seen the results like I saw, with only one person, and questioned Dr. Lawrence at length like I did about the things that he is doing, I just believe that you would see this thing in the same light that I see it.

As you know, as everybody knows, I am not one to spend people's money recklessly, but I made myself a promise long ago that I would not economize on anything that was needed to relieve human suffering. This falls right in the middle of that category. I certainly feel that while a million dollars is a lot of money, compared to other items in the bill for which we have appropriated money, it is a drop in the bucket. I believe progress has been made and greater progress will be made by the Atomic Energy Commission officials in charge of the program.

Mr. PILLION. Will the gentleman yield? I certainly agree with the gentleman's statement as to his anxiety to relieve human suffering. However, I believe there are limitations to some of these studies. In fact, I think it has become a slogan in this country, all you have to do is take any project and put the label of research on it and you are not permitted to open up the can or bottle because it says research on it. I think like any other endeavor, it should be looked at carefully to see that it has a practical application along with some theoretical knowledge that might be applied at a later date, and that there are some limitations to it and there are costs to it and there are values to be derived or not to be derived. I think that this committee is within its province, properly so, to look at it and evaluate it to determine whether that is the right place to spend our money or not.

Thank you, Mr. Jensen.

Dr. DUNHAM. Could the general manager say a word?

Mr. RABAUT. Yes.

BIOLOGIC EFFECT OF RADIATION

General LUEDECKE. We have spoken with respect to this program primarily with application to disease. I think equally important here

and practical is the matter of determining the biologic effect of radiation in an environment in which mankind works. This is really the key to the extent to which we will be able to apply atomic energy in an atoms for peace program. A very major portion of the effort that goes into it in a practical matter is reflected in the location of nuclear reactors for production of power, the extent of shielding, how much radioactivity can be allowed to get into the atmosphere or into the water or into the environment in which we live. I think moneywise this is the major part of the program and as a practical matter it is essential that we get this knowledge.

Mr. FLOBERG. Mr. Chairman, could I point out to Mr. Pillion too that while I agree with him that research should not be a sacred cow, that is immune to scrutiny, one of the benefits of the medical program has been the remarkably low casualty records, remarkably high safety records that this industry has enjoyed in its relatively short life, it is true, but nevertheless it is pretty spectacular.

Mr. RABAUT. Please insert a 5-year comparison of the amount available and actual cost.

(The information follows:)

Biology and medicine program—Comparison of amount available with actual cost experience

[In millions of dollars]

	Amount available	Actual	Difference
Operating costs:			
Fiscal year 1955	$27.0	$27.1	$0.1
Fiscal year 1956	27.0	28.0	1.0
Fiscal year 1957	31.5	32.5	1.0
Fiscal year 1958	36.0	35.3	−.7
Fiscal year 1959	43.0	42.0	−1.0

TRAINING, EDUCATION, AND INFORMATION

Mr. RABAUT. Now, we will take up training, education, and information. $14.2 million is requested. We will insert pages 203 to 229.

(The justification is as follows:)

TRAINING, EDUCATION, AND INFORMATION—OPERATING COSTS

Program statement

Estimate fiscal year 1961	$14,200,000
Estimate fiscal year 1960	13,500,000
Increase	700,000

The training, education, and information program is designed to broaden the base of nuclear knowledge and technology at home and abroad. Program efforts are directed toward the provision of assistance to colleges and universities in establishing nuclear curriculums; the operation, through contract, of schools and the conduct of specialized courses; the offering of graduate fellowships in the nuclear energy field; providing special assistance to States for training in radiation control; the presentation of international conferences, studies, and exhibits; and the organization and dissemination of technical information.

Stimulated to a large extent through assistance provided by the Commission, the capability of American colleges and universities to provide fundamental nuclear energy curriculums has shown continued improvement. Reflecting this

trend, emphasis in Commission-operated schools and courses has shifted from a basic nuclear curriculum, toward more advanced types of courses utilizing the special facilities of the Commission to provide special training opportunities to qualified participants. Transition to a more advanced curriculum at the Argonne International Institute as well as the offering of specialized courses at Shippingport, the Oak Ridge National Laboratory, and the New York Health and Safety Laboratory attest to the changing emphasis of Commission activity in this area.

The program of assistance to regular academic institutions through financial grants for the purchase of training equipment, the provision of materials and teaching aids for use in classrooms, and the provision of special training opportunities for qualified faculty will be continued in an effort to meet the long-range needs of the atomic era by providing a foundation for increasing the numbers of technical manpower adequately prepared in the field of fundamental nuclear energy technology.

Public Law 86-373, amending the Atomic Energy Act of 1954, and approved on September 23, 1959, provides for cooperation with States and has as one of its purposes "to establish procedures and criteria for discontinuance of certain of the Commission's regulatory responsibilities with respect to byproduct, source, and special nuclear materials, and assumption thereof by the States." Section 274(i) of the act authorizes the Commission to provide training to employees of any State or political subdivision thereof as a means of assisting the States to assume the regulatory responsibilities in these areas now assigned to the Commission. In assisting the States to take over this responsibility, the Commission will provide both administrative and technical training, through formal courses as well as on-the-job training. The program will be directed toward familiarizing State personnel with the day-to-day operations and problems handled by the Commission's Divisions of Licensing and Regulation, and Inspection, and will provide experience for these trainees under actual working conditions. The early assumption by the States of the regulatory and inspection functions from the Federal Government will depend in large measure on the availability of this training.

The increasing importance of atoms-for-peace activities as an integral part of U.S. foreign policy places a continuing responsibility on the Commission to provide special nuclear training opportunities for foreign nationals and to provide advisory and consultant services to regional groups of countries such as the Organization for European Economic Cooperation, etc. In addition, programs involving support of nuclear topical conferences and the presentation of oversea nuclear energy exhibits are being continued.

In carrying out its responsibilities for the dissemination of scientific and technical information, the Commission provides a nuclear science information service; prepares books, technical reviews, and information releases; translates foreign language scientific materials; produces and purchases audiovisual and pictorial materials; and carries on a domestic exhibits program.

Summary of estimates by category

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
1. Training and education in reactor technology	$3,413,566	$3,775,000	$4,000,000
2. Training and education in radiobiology and the life sciences	2,316,394	3,150,000	3,300,000
3. Training and education of foreign nationals in nuclear science and technology	1,416,817	2,103,000	2,200,000
4. Training assistance to States in radiation control	0	0	300,000
5. Information services	2,922,019	3,197,000	3,400,000
6. International conferences, exhibits, and studies	2,965,097	1,275,000	1,000,000
Total training, education, and information program	13,033,893	13,500,000	14,200,000

JUSTIFICATION OF CATEGORIES

1. Training and education in reactor technology, $4,000,000

The primary purpose of this program is to assist colleges and universities to develop undergraduate and graduate level teaching capabilities in nuclear science and engineering in order to meet the estimated needs of all related segments of the atomic industry. This purpose is accomplished through a three-pronged approach: Providing equipment and materials assistance to the schools for their laboratories, providing training opportunities to faculty members, and assuring a reasonable number of top-quality students through graduate fellowships. In addition, current manpower needs are satisfied through support of the AEC schools and short courses in highly specialized areas of nuclear technology.

Funds requested for fiscal year 1961 will continue programs in nuclear science and engineering for increasing the supply of technical manpower required.

Summary of estimates by activity

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
Training and education in reactor technology:			
(*a*) Operating of schools and conduct of courses	$160,952	$100,000	$120,000
(*b*) Fellowships	426,028	550,000	630,000
(*c*) Assistance to schools	2,754,854	3,025,000	3,150,000
(*d*) Other training, education, and information activities	52,124	100,000	100,000
(*e*) Equipment not included in construction projects	19,608	0	0
Total training and education in reactor technology	3,413,566	3,775,000	4,000,000

(*a*) Operation of schools **$120,000**

The following is a summary of the items in this activity:

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
1. Oak Ridge School of Reactor Technology	$65,297	0	0
2. Shippingport program for reactor supervisors	95,655	$100,000	$120,000
Total, operation of schools	160,952	100,000	120,000

Oak Ridge School of Reactor Technology (ORSORT):

Fiscal year 1959	**$65,297**
Fiscal year 1960	**0**
Fiscal year 1961	**0**

The Oak Ridge School of Reactor Technology, established as an interim measure to fill AEC and industry training needs at a time when universities had no offering in the nuclear field, fulfilled its primary function, and support of this activity was terminated in fiscal year 1959. Fiscal year 1959 operating costs for the ORSORT school were $65,297.

Shippingport program for reactor supervisors:

Fiscal year 1959	**$95,655**
Fiscal year 1960	**100,000**
Fiscal year 1961	**120,000**

As the program for AEC, other agencies and privately supported power reactors continues to expand, there is increased need for training personnel to operate nuclear power reactors. The AEC, in recognition of its obligation to help meet this need, established a training program at Shippingport in fiscal year 1959 for supervisory personnel of those companies having firm commitments to design

and operate power reactors. This course provides practical training in the operation and maintenance of a large nuclear power station. Three 4-month courses with approximately 20 students per course will be offered in fiscal year 1961. A tuition charge of $2,000 per student has been established. The estimated student load, costs, and revenues for Shippingport are as follows:

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
Number of students	19	50	60
Operating cost	$95,655	$100,000	$120,000
Revenues	$38,000	$100,000	$120,000

The increase of $20,000 is required to train the additional student load in fiscal year 1961.

(*b*) Fellowships:

Fiscal year 1959	$426,028
Fiscal year 1960	550,000
Fiscal year 1961	630,000

The AEC special fellowship program in nuclear science and engineering provides for approximately 150 fellowships for graduate study leading to advanced degrees. This program has a twofold purpose: to help maintain U.S. scientific leadership by encouraging many of the best scientific and engineering minds to pursue graduate work in nuclear science and engineering, and to encourage universities in strengthening their academic work in nuclear areas by providing highly qualified students and, in general, stimulating demand for nuclear curricula. The increase in fiscal year 1961 represents a change from paying actual tuition charges to paying a flat uniform grant of $1,800 per student to the fellowship university in line with NSF and HEW practice.

(*c*) Assistance to schools:

Fiscal year 1959	$2,754,854
Fiscal year 1960	2,025,000
Fiscal year 1961	3,150,000

The AEC maintains a series of programs aimed at encouraging and assisting educational institutions to establish an improved program in nuclear science and engineering. This assistance is in the form of equipment grants, provision of nuclear materials and services, courses of instruction for university and technical institute faculty, and research and on-the-job training opportunities for faculty and students. The programs are interrelated and universities usually participate in all these activities. Under the program of equipment assistance, educational institutions are provided with equipment for teaching purposes, and the organization receiving such assistance must guarantee that the equipment will be used in lecture, demonstration, and formal laboratory courses. Examples of the types of equipment provided are teaching reactors, reactor simulators, subcritical assemblies, and other unique nuclear apparatus for instructing students. In addition, AEC lends without charge, special nuclear material not commercially available, fabricates neutron sources, reprocesses spent fuel elements and performs a number of additional services for universities. Furthermore, under various training programs for university faculty, colleges and universities are enabled to increase the level of competence and knowledge of their staff members in the nuclear field. It has been necessary to conduct intensive programs for dissemination of information on nuclear technology to university staffs by means of formal courses, seminars and on-the-job training because most university staff members received their academic training before sufficient information in the nuclear field was declassified or otherwise available. In cooperation with the American Institute for Engineering Education, summer institutes in nuclear technology are offered for faculty members of colleges, universities, and technical institutes. Wherever feasible, formal educational programs are offered on university campuses, with the AEC sites offering courses utilizing highly spe-

cialized equipment not normally found on university campuses. In addition, both students and faculty are provided opportunities for research work and on-the job training at AEC contractor sites. The costs in fiscal year 1961 remain essentially the same as those in fiscal year 1960. The following is a summary of the items in this activity:

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
Reactor training equipment grants	$2,262,786	$1,800,000	$2,000,000
Development of pedagogical tools	54,242	0	0
Summer institutes for engineering faculty	296,119	400,000	325,000
Research participation program in reactor technology	32,665	125,000	125,000
Materials and services	109,042	700,000	700,000
Total, assistance to schools	2,754,854	3,025,000	3,150,000

(*d*) Other training, education, and information activities:

Fiscal year 1959	$52,124
Fiscal year 1960	100,000
Fiscal year 1961	100,000

In addition to the individual programs described above, there are a number of activities essential to the total program in order to fulfill the varied technical needs of both educational institutions and industrial organizations. Items presently being programed include short courses in specialized subjects such as criticality, use of reactors for process heat, and heat-transfer problems in reactor design; a film on nuclear education; curricula development; preparation of nuclear laboratory manuals; assistance to science fair activities; and a study by the American Society of Engineering Education on the status of nuclear science and engineering education. This activity will continue at the fiscal year 1960 level of $100,000.

2. Training and education in radiobiology and the life sciences, $3,300,000

The costs incurred under this category are concerned with training activities in the life sciences. Four areas of training comprise the major portion of these costs. These are: (1) Operation of the Oak Ridge Institute of Nuclear Studies for the training of research workers in the use of radioactive materials; (2) special fellowship offerings in health physics, industrial medicine, and industrial hygiene; (3) isotope training assistance provided by means of grants to schools for the acquisition of materials, apparatus, and equipment; and (4) summer institutes for faculty training both at the high school and college level.

Summary of estimates by activity

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
Training and education in radiobiology and the life sciences:			
(*a*) Operation of schools and conduct of courses	$196,202	$212,000	$210,000
(*b*) Fellowships	498,184	630,000	638,000
(*c*) Assistance to schools	1,367,236	1,919,000	2,110,000
(*d*) Other training, education, and information activities	167,354	295,000	280,000
(*e*) Equipment not included in construction projects	87,418	94,000	62,000
Total, training and education in radiobiology and the life sciences	2,316,394	3,150,000	3,300,000

(*a*) Operation of schools and conduct of courses:

Fiscal year 1959	$196,202
Fiscal year 1960	212,000
Fiscal year 1961	210,000

The following items are included in this activity:

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
1. Special training program (radioisotopes)	$148,763	$162,000	$166,000
2. Traveling science teachers program	47,439	15,000	8,000
3. Mobile isotope training program	0	35,000	36,000

1. The special radioisotope training program is conducted at Oak Ridge by the Oak Ridge Institute of Nuclear Studies. The primary purpose of this program is the training of research workers in the use of handling of radioactive materials. Training consists of courses in instrumentation, radiation detection, and safety and protection. The courses consist of laboratory work, lectures on laboratory experiments, general background lectures and special-topic seminars, with the major portion of the time devoted to the laboratory. The increase of $4,000 for fiscal year 1961 is required for increased faculty salary and transportation costs.

The estimated number of participants, costs, and revenues are as follows:

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Participants	240	250	250
Operating costs	$148,763	$162,000	$166,000
Revenues	$6,000	$6,250	$6,250

2. The traveling science teachers program is a program whereby specially selected teachers employed in high schools of the country receive 3 months of intensive training at Oak Ridge. During the subsequent school year they visit high schools throughout the States and then return to their regular teaching posts at the end of their year's appointment. Training includes special lectures in science and mathematics, instruction in teaching and laboratory demonstration techniques, and the development of low-cost demonstration apparatus. In the field, after the training period, they spend a week at each scheduled high school lecturing (with demonstration) and conferring with students, teachers, and administrators. Prior to fiscal year 1960, the salaries of the teachers, transportation, and direct costs were supported by the National Science Foundation, with Oak Ridge training costs and the costs of demonstration material being borne by the AEC. In fiscal year 1960 and fiscal year 1961 the cost of this program will be supported wholly by NSF except for costs to the Commission for monitoring the school facilities at Oak Ridge during the 3-month summer training period.

3. Mobile isotope training program: This training has the same objective as the courses offered by the special radioisotope training program described above, but will utilize a 35-foot bus-type mobile laboratory staffed by experienced lecturers and instructors from ORINS. A 2-week course covering the basic principles, techniques, and application of radioisotopes will be conducted at undergraduate colleges and universities through lectures and direct laboratory experimentation. Participants will be comprised of faculty members and selected students majoring in a natural science. Approximately 12 to 15 institutions will be visited each year with average attendance of 15 to 20 students per school. The estimated cost provides for instructors salaries, travel, materials and supplies, and maintenance and operation of the mobile laboratory. This program is supported entirely by the AEC.

(*b*) Fellowships:

Fiscal year 1959	$498,184
Fiscal year 1960	630,000
Fiscal year 1961	638,000

The types of fellowships and their cost by years are as follows:

	Actual fiscal year 1959		Estimate fiscal year 1960		Estimate fiscal year 1961	
	Number	Amount	Number	Amount	Number	Amount
Health physics	150	$348,314	188	$436,000	165	$380,000
Industrial hygiene	8	50,911	8	50,000	12	72,000
Industrial medicine	12	98,959	12	100,000	12	100,000
Advanced graduate study in health physics		0	5	44,000	10	86,000
Total fellowships	170	498,184	213	630,000	199	638,000

In the field of nuclear sciences, as related to the life sciences, there is an increasing need to understand the problem inherent in the degrees of radioactivity to which man and his environment are exposed from reactors, high-energy accelerators, and the now common use of radioisotopes in research medicine. These sources of radioactivity pose potential hazards, not only to the workers themselves but also to the population as a whole should the environment become unduly contaminated. Thus, there is a need for persons who understand these hazards and how to control them, and who also have sufficient knowledge of atomic developments that they can work with scientists and engineers safely in promoting useful developments. The AEC is endeavoring to fulfill this need by offering fellowships in the major areas explained below.

Health physics fellowships offer 1-year of university graduate-level training in the associated sciences of radiation physics and biophysics, including the study of interaction of radiation with living systems; dosimetry and instrumentation. The academic training is followed by 10 weeks of on-the-job training in one of the Commission's national laboratories. The estimate provides for 188 fellows in fiscal year 1960 and 165 fellows in fiscal year 1961.

Industrial hygiene is a specialized science within the field of industrial health and includes the study and control of the more common occupational hazards and other environmental factors affecting the health of atomic energy industry employees. This program offers 1 academic year of graduate training leading to the master's degree in industrial hygiene. The atomic energy industry is encountering more and more industrial hygiene problems with the processing of and experimentation with radioactive materials. These problems are creating an urgent need for industrial hygienists. These fellows create a pool of adequately trained persons in this critical field of science. The estimate for fiscal year 1961 provides for an increase from 8 fellows in fiscal year 1960 to 12 in fiscal year 1961.

Industrial medicine fellowships consist of advanced training at a university which offers an approved graduate course in industrial medicine, industrial hygiene, industrial toxicology, nuclear physics, biophysics, biostatistics, and the public health aspects of occupational medicine. The estimate provides for continuation of the fiscal year 1960 level of 12 fellowships.

Advanced graduate study in health physics fellowships provides for training of health physicists at the doctoral level in order to have available trained individuals capable of administering large health physics programs. It is planned to increase the number of fellowships offered from 5 in fiscal year 1960 to 10 in fiscal year 1961. This level of support will assist in alleviating an acute shortage of highly trained senior health physicists.

(c) Assistance to schools:

Fiscal year 1959	$1,367,236
Fiscal year 1960	1,919,000
Fiscal year 1961	2,110,000

This activity provides for financial grants for the purchase of nuclear equipment and materials; summer institutes in radiation biology for high school and college teachers; special advanced courses in nuclear medicine for individuals possessing a medical degree; and administrative costs for providing qualified speakers to

lecture at small colleges, universities, and at high schools. The following is a summary of the items in this activity:

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Life sciences training equipment grants	$1,027,155	$1,100,000	$1,000,000
Faculty training	340,081	819,000	1,110,000
Radiobiology training for high school science teachers	310,174	600,000	750,000
Radiobiology lecture series	3,857	10,000	10,000
Radiobiology training for college faculty	26,050	159,000	300,000
Advanced radioisotopes training-medical	0	50,000	50,000
Total assistance to schools	1,367,236	1,919,000	2,110,000

The program of life sciences training equipment grants was begun in fiscal year 1958 to assist nonprofit educational institutions by awarding financial grants for the acquisition of special equipment and demonstration apparatus necessary to present laboratory course work in nuclear technology as applied to the life sciences.

Equipment secured through these grants is intended specifically for teaching aids rather than for research activities. The rapid technological advancement and increasing biological implications in the field of nuclear energy create a proportionate need for more and better trained scientists in the field of radiation biology generally, and the use and handling of radioisotopes specifically. This program meets the Commission's responsibility in this area. Grants are available to medical schools, schools of pharmacy, agricultural colleges, biological divisions of liberal arts colleges and universities, and schools of public health. This program will be continued at approximately the fiscal year 1960 level.

The major course under the faculty training program is that in radiobiology training for high school science teachers. This course in general is designed to contribute to the national effort toward increasing the number of scientists in the special and still new field of nuclear technology by (1) introducing the fundamentals of the field to high school teachers and thus to their students, and (2) by attracting individuals toward scientific careers at this appropriately early education level. The increase in this program will allow for an expansion from 20 to 25 summer institutes with a continued effort to locate these institutions geographically throughout the United States. This program is administered in cooperation with the National Science Foundation, with the Foundation providing the cost of stipends and family allowances, and the Commission providing the funds to cover demonstration materials and operational costs.

The radiobiology lecture series program provides lectures from among scientists recognized for their work and competence in the research field of radiation biology to colleges and universities. Costs under this program include transportation, per diem, and fees for lecturers. This program will continue at the fiscal year 1960 level under the auspices of the American Institute of Biological Sciences.

Complementing the program of radiobiology training for high school science teachers is the program commenced in fiscal year 1959 of training in radiation biology at the college level. In order that curriculums may be initiated in the field of radiation biology in institutions of advanced learning, it is necessary to train qualified faculty from colleges and universities throughout the United States. The increase in this program will allow for an expansion from 5 to 10 institutes.

The advanced radioisotopes medical training program provides advanced special courses for individuals possessing medical degrees. This program provides an intensive course of training in the applications of nuclear technology in such areas as medical research, diagnotic procedures, therapeutic applications, and general problems of public health.

(*d*) Other training, education, and information activities:

Fiscal year 1959	$167,354
Fiscal year 1960	295,000
Fiscal year 1961	280,000

This activity provides for the summer fieldwork phase of the life sciences fellowship programs. Fellowship recipients who have completed their regular university academic training are assigned to one of the Commission's laboratories for special lectures and participation in a work experience program designed to familiarize the trainee with day-to-day problems encountered at the laboratory. Training is provided at the Brookhaven and Oak Ridge Laboratories and at the University of Rochester atomic energy project. The estimate of $180,000 required for this program provides for the direct salaries and travel of participating fellows.

Also included in this activity are funds for the preparation of educational bulletins, and manuals, training films, curriculums development, and educational seminars. An amount of $100,000 is required for this activity.

(*e*) Equipment not included in construction projects:

Fiscal year 1959	$87,418
Fiscal year 1960	94,000
Fiscal year 1961	62,000

The estimate provides for equipment requirements at the Oak Ridge Institute of Nuclear Studies for major replacement and remodeling of the basic laboratory and classroom equipment including worktables, sinks, and cabinets. In addition, replacement of operational equipment and instrumentation is required to take advantage of the most up-to-date pedagogical devices. There follows a comparison of other operating costs with equipment costs for training and education activities in radiobiology and the life sciences.

	Other operating costs	Equipment costs
Oak Ridge Institute of Nuclear Studies	$210,000	$62,000
All other	3,028,000	0
Total	3,238,000	62,000

3. Training and education of foreign nationals in nuclear science and technology, $2,200,000

The announcement of the atoms-for-peace program before the United Nations on December 8, 1953, placed the United States in a leading position in international cooperation in the peaceful uses of nuclear energy. In order to achieve the objectives of this program, foreign nations must have trained technical personnel to make efficient use of the information and material acquired under the program. Herertofore, the Commission offered training programs in basic principles of nuclear science and technology. Today many educational institutions and industrial organizations in this country and abroad have developed basic nuclear science training programs. The Commission, taking full advantage of the now available basic training, is currently offering highly advanced training in each of the various scientific and engineering disciplines of nuclear technology. Our obligations to the International Atomic Energy Agency and Euratom are important additional factors which emphasize the continuing need for the United States to sponsor highly advanced and specialized training for foreign nationals.

Summary of estimates by activity

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
Training and education of foreign nationals in nuclear science and technology:			
(*a*) Operation of schools and conduct of courses	$1,057,604	$1,530,000	$1,767,000
(*b*) International conference, exhibits, studies	89,186	200,000	200,000
(*c*) Equipment not included in construction projects	270,027	373,000	233,000
Total, training and education of foreign nationals in nuclear science and technology	1,416,817	2,103,000	2,200,000

(a) Operation of schools and conduct of courses:

Fiscal year 1959	$1,057,604
Fiscal year 1960	1,530,000
Fiscal year 1961	1,767,000

The Commission's provision for nuclear training on an international scale is an important facet of the atoms-for-peace program. The courses offered in these training programs have changed to reflect technical advances in nuclear scientific disciplines and are designed to stimulate participation of the highest level scientists. Courses at the international school have been modified to help meet the need for highly advanced and specialized training as well as to take full advantage of the increasing number of universities that are able to offer basic training in this field. The provision of high level training opportunities in advanced nuclear sciences assures U.S. leadership in the increasingly important international scientific community.

The following is a summary of the items in this activity:

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
International Institute of Nuclear Science and Engineering	$638,878	$728,000	$840,000
Puerto Rico Nuclear Center	337,112	650,000	750,000
Health and safety laboratory course	3,165	12,000	12,000
Reactor hazards and supervisors course	78,449	140,000	165,000
Total, operation of schools	1,057,604	1,530,000	1,767,000

International Institute of Nuclear Science and Engineering, Argonne National Laboratory:

Fiscal year 1959	$638,878
Fiscal year 1960	728,000
Fiscal year 1961	840,000

From its inception in fiscal year 1955 through December 1959 the International School offered fundamental nuclear curricula not otherwise available through regular academic channels. Aided to a large extent through assistance provided by the Commission, basic course offerings have become increasingly available in American colleges and universities. Accordingly, with the graduation of the ninth class in December 1959, the basic course offerings of the International School were terminated. The curriculum of the school has now been reoriented to provide highly specialized and advanced training utilizing the unique facilities and nuclear training equipment available to the Argonne National Laboratory.

Appointments to the Institute are on two levels. The first, the "participant" level, requires the equivalent of the master's degree in science and engineering given in the United States and a background in nuclear studies. Participants are selected for one or two 16-week semesters. Tuition for scientists and engineers on this level is $1,000 per semester.

The second, or "affiliate," level is more advanced, requiring the equivalent of the doctor of philosophy degree given in a U.S. university. Affiliates are accepted by the Institute for a minimum of two semesters and their abilities must be such as to enable them to contribute significantly to the overall Argonne Laboratory research program in developing peaceful applications of atomic energy. No tuition is charged at the affiliate level.

In fiscal year 1959, operating costs for the International School were $638,878. A total of 118 students attended the seventh and eighth sessions of the school with tuition revenues amounting to $55,000. In fiscal year 1960, operating costs are estimated to be $728,000. During fiscal year 1960, 44 students attended the ninth and last session of the original International School which closed in December 1959. The first session under the Institute's advanced curriculum began February 3, 1960, with 52 students in attendance. The second session of the Institute will commence June 8, 1960, with an estimated 42 students in attendance. Total tuition revenues estimated in fiscal year 1960 amounts to $100,000. In fiscal year 1961 operating costs are estimated to be $840,000. Student attendance during fiscal year 1961 is estimated at 140. Of this total, 120 are expected to be "participants" and 20 are expected to be "affiliates."

There follows a summary of the operating costs, student attendance and revenues estimated for the International School.

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Operating costs	$638,878	$728,000	$840,000
Number of students	118	138	140
Basic curriculum students	118	44	0
Advanced curriculum students	0	94	140
Participants	0	57	120
Affiliates	0	37	20
Revenues	$55,000	$100,000	$120,000
Basic curriculum students	55,000	43,000	0
Advanced curriculum students	0	57,000	120,000
Participants	0	57,000	120,000
Affiliates	0	0	0

The increased costs for fiscal year 1961 are due to the additional number of man-years for instruction and additional materials and services required for this diversified and advanced level of training.

Puerto Rico Nuclear Center:

Fiscal year 1959	$337,112
Fiscal year 1960	650,000
Fiscal year 1961	750,000

The Puerto Rico Nuclear Center, developed in cooperation and under contract with the University of Puerto Rico, offered courses of nuclear science and technology and in radioisotopes techniques in temporary facilities at the Mayaguez and Rio Piedras campuses during fiscal years 1958, 1959, and 1960. The center, including the reactor and laboratory facilities, will be completed and operating at capacity during fiscal year 1961. The curricula presented by the center will be on a regular academic year basis with courses being offered in nuclear science and engineering, radiological physics, radioisotopes techniques, clinical radioisotopes, and radiotherapy. Students attending the center are assessed a tuition charge of $6.25 per credit hour. It is assumed that each student will carry an average of four credit hours.

The estimated student load, costs, and revenues for PRNC are as follows:

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Number of students	84	148	268
Operating costs	$337,112	$650,000	$750,000
Revenues	2,000	3,000	7,000

The increase in cost for fiscal year 1961 is primarily for costs of additional instructors' salaries and additional materials and services necessary to operate a fully staffed training center.

Radioisotope monitoring techniques course, Health, and Safety Laboratory, New York:

Fiscal year 1959	$3,165
Fiscal year 1960	12,000
Fiscal year 1961	12,000

In March 1956, the U.S. representative at the United Nations Scientific Committee on the effects of atomic radiation made an offer of technical assistance, training and processing of samples in Commission laboratories. Many countries expressed interest in receiving this assistance. In order to provide specialized instruction in monitoring techniques and radiochemical counting procedures, a

course was initiated in October 1958, at the New York Operations Office Health and Safety Laboratory. There is no indication that universities or non-AEC facilities will be able to provide similar instruction through fiscal year 1961. This program consists of four courses per year, each of 6 weeks duration, accommodating six students in each course. A registration fee of $25 is charged each participant. The instruction includes use of low level counting equipment, identification and determination of activity of specific radioisotopes, the development of specialized analytical methods, the distribution of fission products in the atmosphere, and the philosophy and interpretation of measurements. The amount requested for fiscal year 1961 provides for a continuation of the monitoring techniques course at the fiscal year 1960 level. The estimated student load, costs, and revenues for this course are as follows:

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
Number of students	11	24	24
Operating cost	$3,165	$12,000	$12,000
Revenues	$275	$600	$600

Reactor hazards and supervisors courses, Oak Ridge National Laboratory:

Fiscal year 1959	$78,449
Fiscal year 1960	140,000
Fiscal year 1961	165,000

Two advanced specialized courses not previously available in the United States were initiated in fiscal year 1959 at the Oak Ridge National Laboratory. The first course, which is called the nuclear reactor operations supervision course, endeavors to prepare the participants to superintend the operation of power or research reactors efficiently and safely. This 9-month course is directed toward technical management problems and the development of proficiencies necessary for managing reactor facilities. The second course, which is called the nuclear reactor hazards evaluation course, is a 1-year program designed to train participants to evaluate the many hazards encountered in the operation of reactors including those associated with criticality. These courses are highly technical and specialized. Equivalent instruction is not available at universities and industrial institutions.

It is anticipated that these two courses will be offered to approximately 26 applicants during fiscal year 1961. A tuition fee of $2,000 per student is charged. While these courses are primarily for foreign nationals, enrollment of U.S. citizens is encouraged.

The estimated student load, costs, and revenues for these two courses are as follows:

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
Number of students	26	25	26
Nuclear reactor operations supervision course	10	11	10
Nuclear reactor hazards evaluation course	16	14	16
Operating costs	$78,449	$140,000	$165,000
Revenues	$52,000	$50,000	$52,000

The increase of $25,000 is required for moving the school from a temporary building scheduled for destruction to a permanent building.

(*b*) International conferences, exhibits, and studies:

Fiscal year 1959	$89,186
Fiscal year 1960	200,000
Fiscal year 1961	200,000

The estimate for this activity provides for advisory and consultant services to regional groups of countries such as the Organization for European Economic Cooperation, Euratom, etc. (excluding, however, the IAEA and the U.N.). It also provides for U.S. participation in meetings and conferences sponsored or cosponsored by these groups. The consultant and advisory services will be provided by individuals or small groups of experts under contract to AEC who will travel to the headquarters of these organizations or to member countries to assist in the evaluation and development of atomic energy programs.

The provision of such advisory and consultant assistance to these groups of countries, constitutes an important facet of the atoms-for-peace program and will materially contribute to the acceleration of peaceful atomic energy activities in many cooperating countries. In addition, these activities will permit U.S. representatives to obtain firsthand information on current technological advances achieved by the member countries of these organizations. This activity will be continued at the fiscal year 1960 level.

(*c*) Equipment not included in construction projects:

Fiscal year 1959	$270,027
Fiscal year 1960	373,000
Fiscal year 1961	233,000

Puerto Rico Nuclear Training Center, $205,000.—This estimate will provide (1) a multichannel gamma ray spectrometer, mechanical neutron velocity selecter, fatigue tester, differential analyzer liquid metal loop and other equipment for the nuclear science and technology program amounting to a total of $81,000; (2) a near critical facility, irradiation facilities and a high-speed oscilloscope for the reactor program amounting to a total of $20,000; (3) monitoring and survey equipment for the health physics program amounting to a total of $9,000; (4) $25,000 for equipment for the radioisotope applications program; (5) $45,000 for equipment for the preclinical and clinical radioisotope program; (6) auxiliary research equipment amounting to $20,000 for the radiotherapy and cancer program, including calibrating and measuring devices and instrumentation indicating the localization and effects of radiation; and (7) $5,000 for office and miscellaneous equipment.

International Institute for Nuclear Science and Engineering, $25,000.—This estimate will provide for replacement of shop and office equipment totaling $6,000 and laboratory equipment in the amount of $19,000.

Health and safety laboratory course, $3,000.—This estimate will provide for the following equipment: two scalers, two 500–4,600 volt regulated power supplies, two flow window counter, two clinical centrifuges, and one preamplifier.

There follows a summary of other operating costs compared with equipment costs estimated for training and education of foreign nationals in nuclear science and technology.

	Other operating costs	Equipment costs
Puerto Rico Nuclear Center	$750,000	$205,000
International Institute of Nuclear Science and Engineering	840,000	25,000
Health and safety laboratory course	12,000	3,000
All other	365,000	0
Total	1,967,000	233,000

4. Training assistance to States in radiation control

Fiscal year 1959	0
Fiscal year 1960	0
Fiscal year 1961	$300,000

Under the provisions of Public Law 86–373 the Commission will establish training programs for employees of States which will provide for a work experience program designed to familiarize State personnel with the day-to-day operations and problems handled by the Commission's Divisions of Licensing and Regulations and Inspection and, in addition, academic-type training primarily in the field of health physics, including classroom lectures, laboratory experiments, and field inspection trips. Although the details of

the program have not been fully established, it is estimated that costs in fiscal year 1961 would amount to $300,000.

5. Information services, $3,400,000

The purposes of this program are to provide technical information services and materials within the AEC and AEC contractors, and to provide for the dissemination of scientific and technical information to meet the needs of the general public, and particularly of educators, scientists, businessmen, and industrialists, and for information concerning scientific and technical developments in the national atomic energy program. These objectives are accomplished by (1) operation of the Technical Information Service Extension at Oak Ridge, which provides classified and unclassified central AEC nuclear science information services; (2) preparation of books, periodic technical reviews, and technical information releases for the business industrial community; (3) translation of foreign language scientific materials; (4) production, purchase, processing, and dissemination of audiovisual and pictorial materials; and (5) operation of domestic exhibits and school demonstration units.

Summary of estimates by activity

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Information services:			
(a) Domestic exhibits	$626,771	$622,000	$646,000
(b) Publications, libraries, translations, and pictorial materials	2,225,951	2,498,000	2,663,000
(c) Equipment not included in construction projects	69,297	77,000	91,000
Total, information services	2,922,019	3,197,000	3,400,000

(*a*) Domestic exhibits:

Fiscal year 1959	$626,771
Fiscal year 1960	622,000
Fiscal year 1961	646,000

The Commission's responsibility under the Atomic Energy Act of 1954 to provide for the dissemination of unclassified scientific and technical information is carried out in part by visual presentations exhibiting peacetime applications of atomic energy. A traveling exhibits program, operated for the Commission by the Oak Ridge Institute of Nuclear Studies, provides for display throughout the country various types of exhibits, such as large temporary installations, mobile walk-throughs and high school demonstration units. These bring the progress in peacetime developments of atomic energy to large audiences at State, county, and local fairs, civic gatherings, and similar events, and to students at the elementary, high school, and college levels. ORINS also operates a museum exhibit for the Commission at Oak Ridge. There is also a special program to provide exhibits designed to familiarize industrial, scientific, engineering, and management personnel with Commission technical programs and developments. Small exhibits are designed and constructed for use at technical and industrial conferences, business meetings, trade fairs, and special dedication ceremonies, etc., where Federal, State, or local government officials or civic leaders request presentations of atomic energy informational displays.

The following is a summary of the items under the activity:

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Museum exhibit (Oak Ridge)	$114,270	$107,000	$107,000
Traveling exhibits program	498,580	495,000	519,000
Industrial information and other special exhibits, headquarters	13,921	20,000	20,000
Total exhibits	626,771	622,000	646,000

(*b*) Publications, libraries, printing, translations, and pictorial materials:

Fiscal year 1959	$2,225,951
Fiscal year 1960	2,498,000
Fiscal year 1961	2,663,000

The Commission's technical information program provides information materials and services to science and industry. In addition, the program implements agreements for international cooperation by furnishing technical information services under the atoms for peace and bilateral agreements programs.

The estimate of $2,663,000 covers activities necessary to fill the needs of the AEC and its contractors, and the needs of science and industry generally for scientific and technical information materials originated within the AEC program. These include the operation of the Technical Information Service Extension at Oak Ridge to provide (*a*) centralized classified and unclassified AEC publishing, reference, abstracting, document collection, and distribution services for the AEC program, (*b*) classified and unclassified technical information services to the Commission's access permit holders under the civilian applications program, and (*c*) primarily unclassified technical information services to domestic depository and educational libraries and to libraries established in foreign countries under the atoms for peace and bilateral agreements programs. The estimate also covers the preparation under contract of unclassified books, compiling technical data essential for peacetime applications of atomic energy; the writing under contract of a series of unclassified technical progress reviews to keep industry abreast of current technical developments in the atomic energy field; the translation of technical data from Russian and other foreign language materials; the printing of materials published and distributed under the industrial participation activities of the Commission; the production, purchase, and processing of audiovisual and pictorial materials; and the conduct of a survey and analysis of methods for the dissemination of technical information as a basis for evaluating the desirability of adopting improved methods. The following is a summary of the items under this activity:

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Classified depository libraries	$19,940	$20,000	0
Technical books program	291,240	295,000	$295,000
Technical progress reviews	79,456	136,000	186,000
Translation program	53,410	100,000	120,000
Printing	147,286	193,000	237,000
Technical information service extension:			
Oak Ridge	1,516,688	1,632,000	1,683,000
Personal services	983,000	1,035,000	1,045,000
Travel	5,559	6,000	6,000
Other objects	528,129	591,000	632,000
Pictorial materials	110,640	82,000	82,000
Other	7,291	40,000	60,000
Total publications, libraries, printing translations, and pictorial materials	2,225,951	2,498,000	2,663,000

(*c*) Equipment not included in construction projects:

Fiscal year 1959	$69,297
Fiscal year 1960	77,000
Fiscal year 1961	91,000

The estimate provides for additions and replacements of office furniture, machines, and printing equipment in connection with scientific and technical information activities. There follows a breakdown of equipment costs indi-

cating amounts estimated for each contractor in relationship to other operating costs under this program:

Installation	Other operating costs	Equipment costs
Domestic exhibit program	$626,000	$10,000
Technical information service extension, Oak Ridge	1,683,000	81,000
All other	1,000,000	0
Total	3,309,000	91,000

6. International conferences, exhibits, and studies, $1 million

The costs estimated for fiscal year 1961 under this program include the support of specialized nuclear topical conferences of interest to the scientific community and the organization and presentation of overseas nuclear energy exhibits.

Summary of estimates by activity

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
International conferences, exhibits, and studies:			
(*a*) Special conferences	$2,503,745	0	0
(*b*) Topical conferences	50,528	$150,000	$150,000
(*c*) International nuclear energy exhibits	410,824	1,125,000	850,000
Total international conferences, exhibits, and studies	2,965,097	1,275,000	1,000,000

(*a*) Special conferences:

Fiscal year 1959	$2,503,745
Fiscal year 1960	0
Fiscal year 1961	0

The Second International Conference on the Peaceful Uses of Atomic Energy was held in Geneva, Switzerland, September 1 through 15, 1958. All costs related to this Conference were completed in fiscal year 1959; hence, no funding will be required in fiscal year 1960 and 1961.

(*b*) Topical conferences:

Fiscal year 1959	$50,528
Fiscal year 1960	150,000
Fiscal year 1961	150,000

Under the topical conference program the Commission grants partial or full financial support to a selected number of international conferences and symposia convened to examine specialized scientific subjects related to atomic energy. Financial assistance to international conferences is used to defray conference expenses which include travel of selected foreign and U.S. scientists, a reasonable share of costs related to publishing the proceedings of the conference, and expenses for secretarial assistance. The conference program for support of special scientific conferences related to atomic energy will require $150,000 during fiscal year 1961. This estimate is based on the assumption that the Commission will support 10 to 15 conferences or symposia at an average cost of $11,000 per conference. This average cost has been determined from past experience in fiscal years 1958–59.

(*c*) International nuclear energy exhibits:

Fiscal year 1959	$410,824
Fiscal year 1960	1,125,000
Fiscal year 1961	850,000

The international nuclear energy exhibits program will require $850,000 during fiscal year 1961. This program, coordinated and approved by the Exhibits Committee of the Operations Coordinating Board and concurred in by State and the U.S. Information Agency, provides for three major exhibits. One exhibit will be held in Karachi, Pakistan, in September 1960; a semimobile exhibit will tour four countries in Latin America (Brazil, Argentina, Venezuela, and Peru) in 1960 and 1961; and one exhibit will be held in the spring of 1961 at a location yet to be determined. In terms of fiscal-year costs, these planned exhibits in comparison with the fiscal year 1960 program will be funded in the following manner:

Location	Date	Estimated costs		Remarks
		Fiscal year 1960	Fiscal year 1961	
New Delhi, India	Dec. 11, 1959–Feb. 14, 1960.	$275,000	0	Total cost was $350,000, of which $75,000 was previously costed in fiscal year 1959.
Cairo, Egypt	May 1960	300,000	0	Many of the exhibit items shown at Cairo would be incorporated in the Karachi exhibit.
Karachi, Pakistan	September 1960	25,000	$125,000	
Undetermined	Spring 1961	125,000	325,000	Location to be determined at later date.
Latin America		400,000	0	1 semimobile exhibit produced to tour the 4 listed countries. (1960 costs will provide the basic exhibit; the 1961 costs provide for estimated additions, transportation, etc.)
Brazil	Fall 1960	0	100,000	
Argentina	Winter 1960	0	100,000	
Venezuela	Spring 1961	0	100,000	
Peru	Summer 1961	0	100,000	
Total		1,125,000	850,000	

Although the costs of producing an exhibit vary according to its size, complexity, and location, it has been found from past experience that the average cost for an exhibit is approximately $250,000 to $350,000. The exhibit in Rome, Italy, in 1958, cost approximately $240,000 and cost for the exhibit in Tokyo, Japan, in 1959, was approximately $340,000. In general, exhibit costs are for design, fabrication, transportation, operation, and dismantlement. On the basis of these average costs, three planned exhibits in fiscal year 1961 will be supported under the budget request of $850,000 for this activity.

Mr. RABAUT. You are budgeting for the first time to implement Public Law 86–373. Please explain this program for which $300,000 is requested.

TRAINING FOR STATE INSPECTION

Dr. SHILLING. This is an effort on the part of the Atomic Energy Commission jointly with the Bureau of State Services of the Public Health Service to help prepare the State representatives to be able to start in on the problems of inspection of the various licensees that the Atomic Energy Commission has.

As you know, sir, we were charged with this responsibility, but it is now being turned over, and rightly so, to the States. Someone has to step in and help educate these individuals.

Mr. RABAUT. Where in the AEC budget and in what amounts can we look for savings as the States begin to take over the licenses inspection responsibility?

Dr. SHILLING. This is not in the education and training program. But there may be some saving in personnel in licensing and inspection, as the States take over this activity.

Mr. RABAUT. Suppose you supply the answer for the record. Since such inspection work is strictly in State interest and of immediate

importance to them in maintaining public health, why can't they either recruit competent personnel or stand the expense of training for their personnel?

Dr. SHILLING. Well, the recruiting situation is quite impossible, sir, because there simply are not enough people yet trained in this area. They are doing their share on the expense. The State is continuing to pay the salary of the individual. The State will pay the transportation. We are only putting up the actual cost of operating the program for them.

(The material referred to follows:)

At the present time no State has a licensing and regulatory program of the type prescribed by Public Law 86-373. It is essential that trained personnel be available to the States preparing to adopt such a program. In the initial year of development of the program under Public Law 86-373, the demands on the AEC staff will increase because of the necessity to help orient and train State personnel and the AEC does not expect any reduction in its staff as a result of the Public Law 86-373 program during fiscal year 1961. Depending on (1) the rate at which the States enter the program and (2) the rate of expansion of license activities on the materials still subject to AEC licensing, it may be possible to reflect savings in later years.

Mr. MCCARTHY. I might say that the budget of $300,000 which is before you contemplated reimbursing the State for travel and per diem expenses. This is not now in the program. Some reduction in the $300,000 is now applicable to the amount. I think the program as it stands, will come to $160,000—$140,000 of which is for travel and per diem is being cut out.

Mr. RABAUT. Do you want to round it off at $100,000?

Mr. MCCARTHY. No, sir.

EQUIPMENT GRANTS

Mr. RABAUT. With respect to your assistance to the school program, the committee has been experiencing some pressure to increase the amount for equipment grants and has noted that the National Science Foundation is of the opinion that the school need for research reactors has been substantially met. Will you comment on this?

Dr. SHILLING. We can supply this for the record without difficulty, sir.

Mr. RABAUT. All right, supply that for the record.

(The material referred to follows:)

The National Science Foundation opinion that the needs of institutions for reactors has been substantially met refers exclusively to research reactors as distinguished from teaching reactors. The NSF provides grant funds to institutions for research reactors whereas the AEC provides grants for teaching reactors. The AEC provides nuclear fuel for both types of reactors. The requirement for teaching reactors is not being met. At present the AEC has qualified proposals from eight universities. Because of reduction in budgeted funds the AEC did not provide grants in fiscal year 1960 for the more expensive pieces of nuclear laboratory equipment, namely teaching reactors. This action enabled AEC to spread reduced funds over more institutions. Backlog of proposals at the time over $7 million. Current backlog over $5 million.

PUERTO RICAN TRAINING CENTER

Mr. RABAUT. The costs for operating the Puerto Rican training center seem to be $2,800 per student. Isn't this high? Why can't the countries who send students there pay more than $6.25 per credit hour?

Dr. SHILLING. The Puerto Rico training center has not really yet gotten underway so that I think at the present time a calculation of cost per student is really not quite firm.

Mr. RABAUT. Do you want to reduce the item?

Dr. SHILLING. No, the item could not be reduced. The only thing is that the actual number last year was not great enough to make this cost figure per person firm.

Mr. RABAUT. Is this predicated on the cost of last year?

Dr. SHILLING. I think it is, sir.

Mr. RABAUT. In 1960 you had 148 students at $2,800 per student. Is that right?

Mr. MCCARTHY. This is correct, sir. The cost that is being charged is comparable to the cost being charged per student.

Mr. RABAUT. Are you predicating the cost down there on the cost in this country?

Mr. MCCARTHY. No. The cost is based on the same cost being charged to students at the University of Puerto Rico.

Mr. RABAUT. Why should we accept their standard of $6.25 a credit hour?

Dr. SHILLING. This is not much out of line with the cost per credit hour in some of our institutions here.

Mr. RABAUT. It should be cheaper than here.

Dr. SHILLING. The operation is actually much more costly there in a number of ways than it is here.

Mr. RABAUT. Our students are all being financed down there, are they not?

Dr. SHILLING. Our students?

Mr. RABAUT. Yes, the Puerto Rican students, the ones other than the Puerto Rican locals.

Dr. SHILLING. No, we furnish the facilities but the country they come from pays for their transportation.

Mr. RABAUT. That is why I figure we should not be paying as much as the Puerto Ricans say. They are getting something from the countries they come from. Is it not going into the coffers of the university?

Dr. SHILLING. No, the country only pays the transportation cost and the actual living cost, that sort of thing, and the tuition.

Mr. MCCARTHY. The cost will always be higher here, Mr. Chairman, in terms of the facilities we are operating because of the fact that we have specialized equipment.

Mr. RABAUT. I am strong for this program but I am wondering if this is the right amount.

CONFERENCE FUNDS

On page 221 you show a fund of $220,000 for sending individuals and small groups to conferences and get-togethers in foreign countries. On page 228 you show another for $150,000 for topical conferences in foreign countries, none of which are scheduled, apparently. The justification for these amounts seems to be that you have been spending about this much in the past. Can you give us any breakdown or justification for continuing these excursions?

Mr. McCarthy. There are two items involved here, Mr. Chairman. I think the first one on page 221, the international conferences and exhibits and so forth, the first item would apply to the consultant services furnished to some of the foreign countries, missions to evaluate their potential in the nuclear power program. I think the other one you are referring to is the exhibits at overseas locations which is an undesignated amount included in that amount. I think the question is, have we exhibits scheduled for that.

Mr. Rabaut. I am talking about this $150,000 for topical conferences in foreign countries.

Mr. Gardner. The topical conferences, small specialized conferences, are usually held either in this country in which foreigners participate under the sponsorship of the university or conferences——

Mr. Rabaut. Are you referring to the item on page 228?

Mr. Gardner. Yes. In which Americans travel to conferences, to small topical conferences overseas, in which their travel and per diem is paid from this fund. During the past year there have been 10 such conferences, and in fiscal 1959 there were 10, and in fiscal 1960 so far there have been 10 conferences.

Mr. Rabaut. Have you any money remaining in the fund from these conferences?

Mr. Gardner. In fiscal 1960 we have now unobligated about $25,000.

Mr. Rabaut. How much did you have in 1960?

Mr. Gardner. We have about $25,000 unobligated now and we had about $50,000 in fiscal 1959.

General Luedecke. $150,000 in 1960.

Mr. Rabaut. So that the committee may have some idea about how you use such funds, please supply for the record a detailed account of persons who are traveling this year under these programs and for what specific purposes. Supply that for the record.

Mr. Gardner. Yes, sir.

(The information follows:)

AEC Topical Conference Program

The Office of Special Projects administers the AEC's program of support of international scientific conferences. These conferences concern specialized areas of research in atomic energy and are normally sponsored by private institutions as well as the AEC. The program of support is designed to assist American scientists in the acquisition of knowledge of recent scientific advances; to help lower the areas impeding the interchange of scientific information among nations; and to promote the peaceful uses of atomic energy throughout the world.

AEC support is normally based on proposals from scientific organizations. The proposal is jointly reviewed (1) by an appropriate AEC program division to determine from a scientific viewpoint whether the conference merits AEC support, and (2) by the Office of Special Projects for approval of funds and for international advantages.

Expenses for conferences usually fall into the following categories: travel of invited speakers both foreign and U.S., publication of proceedings, secretarial assistance, administrative costs of the sponsoring organization including travel in the United States for members of a steering committee.

For support of an international scientific conference held abroad, the program limits support to the payment of a reasonable share of administrative expenses of a sponsoring U.S. organization and the travel and per diem expenses of selected U.S. participants. In those cases where travel and per diem costs are involved, U.S. participants are selected by technical committees after a review of intended papers for presentation. Selected individuals serve at international conferences as chairmen of sessions, panel members, or as selected speakers.

It should be noted from the attached list of conferences that only a limited number have been held abroad and for these conferences U.S. citizens were selected to represent the United States. During the past 3 years, 28 topical conferences have been supported by the AEC and out of these, 6 were held abroad and involved the travel expenses of U.S. participants. The attached list of conferences indicates only those which contained travel expense either in the United States, abroad, or costs of foreign guests to the United States.

Topical Conference program, USAEC—Financial support

FISCAL YEAR 1958

Name of conference	Total AEC support	AEC expenditures	Travel support	Name of traveler and affiliation
5th International Conference on Low Temperature Physics and Chemistry, Aug. 26–30, 1957, University of Wisconsin.	$5,000	Spread over items: Secretarial assistance ..... $1,000 Travel of steering committee .. 500 Publication of proceedings ... 4,500 Travel of invited U.S. speakers. 750 (Total cost of Conference was $30,000 including in addition to above travel of foreign guests and entertainment costs both of which were excluded for AEC reimbursement.)	Lump-sum contract—AEC money together with funds of other contributors used to pay travel. No attempt was made to earmark certain travelers for AEC.	None.
International Conference on Neutron Interactions with Nuclei, Columbia University, New York, Sept. 2–13, 1957.	10,000	Spread over items: Travel of steering committee members ..... $2,000 Administrative costs and incidentals ..... 16,000 Publication of proceedings ..... 10,000 (AEC, Office of Naval Research, Office of Scientific Research (Air Force), and International Union of Pure and Applied Physics shared payment of Conference costs.)	Transfer of funds to Division of Research to supplement a lump-sum contract by that Division. Travelers not earmarked for AEC funds.	Do.
International Conference on the Measurements and Standards of Radioactivity, Easton, Md., Oct. 9–11, 1957.	7,300	U.S. travel for cost of foreign guests. $3,400 Publication of proceedings ..... 2,700 Incidentals and overhead ..... 1,200 (AEC shared expenses with the NAS which contributed an equal amount for support of the Conference.)	The travel cost involved for this Conference amounted to $3,400. This travel was performed within the United States transporting participants to and from the Conference. It was regarded in the budget as administrative expenses and AEC money was not earmarked for certain travelers.	Do.
International Symposium on Health Physics, May 1958, University of Puerto Rico.	5,939	Secretarial services ..... $1,200 Printing ..... 100 Stenotype services ..... 700 Translation services ..... 300 Travel and living expenses ..... 3,369 Total 5,939	$3,369	Dr. Henri Verret, Chef du Service de Radiologie a e' Hospital Gen. Haitien, Haiti; Dr. Salvador Vilanova Castro, Hospital Rosales, El Salvador; Dr. Sidney Patrick, University College of the West Indies; Dr. Zollo Marinello, Calle K 420, Cuba; Dr. David Avillo, School of Medicine, Guatemala; Dr. Ruheni Tamayo, Hospital Frances, Mexico.

Topical Conference program, USAEC—Financial support—Continued

FISCAL YEAR 1959

Name of conference	Total AEC support	AEC expenditures	Travel support	Name of traveler and affiliation
International Conference on Stopping Power, Gatlinburg, Tenn., Sept. 15–18, 1958.	$6,325	Travel and living expenses of U.S. and foreign participants: Travel ..... $9,000 Clerical ..... 300 Communications ..... 200 Publications of proceedings ..... 1,500 Overhead ..... 1,650 Total ..... 12,650 (AEC-approved overhead for NAS.) The above amounts were shared on an equal basis with the National Science Foundation; AEC costs therefore $6,325.	$4,500	John S. Coleman, NAS; J. B. Hasted, London, England; Paul Huber, Basel, Switzerland; M. Scharff, Copenhagen, Denmark; Hiroshi, Watanabe, Tokyo, Japan; Hans Bichsel, University of Washington; Philippe Nozieres, France; Michel Gryzinski, Poland; S. N. Ghosh, India; R. L. Platzman, Purdue University; Edwin A. Uehling, University of Washington; Jens Lindhard, Denmark; Pierre Cüer, France; J. N. Cooper, U.S. Navy Postgraduate School, California.
7th International Cancer Congress, London, England, Oct. 10–16, 1958.	10,000	Travel expenses of U.S. participants $10,000.	$10,000	Jacob Furth, Children's Cancer Research Foundation; Henry Kaplan, Stanford University; Paul Zamecnik, Massachusetts General Hospital; Roy Albert, George Washington University; Jeanne Bateman, Garfield Hospital; W. E. Cornatzer, University of North Dakota; Edward D. DeLamater, University of Pennsylvania; John Freymann, Massachusetts General Hospital; P. F. Hahn, Meharry Medical College; W. Eugene Knox, New England Deaconess Hospital; Armand Littman, University of Illinois; David Pressman, Roswell Park Memorial Institute; Philippe Shubik, Chicago Medical School; William H. Sweet, Massachusetts General Hospital; John L. Tullis, New England Deaconess Hospital.
International Conference on Radiation Research, Burlington, Vt., Oct. 10–16, 1958.	15,492	Administrative expenses ..... $649 Secretarial services ..... 4,470 Travel ..... 8,353 Overhead ..... 2,020 Total ..... 15,492 (AEC-approved overhead expenses for NAS.) In addition to the AEC, 4 other Government agencies plus the Rockefeller Foundation and several private industrial firms supported the Conference.	AEC money used for travel of U.S. participants. These travelers were not earmarked by NAS.	None.

International Conference on Semiconductors, University of Rochester, Rochester, N.Y., Oct. 18–22, 1958.	18,300	Travel and per diem for foreign participants $5,506 Publication and printing costs 1,632 Administrative expenses 1,100 Incidentals 62	$5,506. This amount represents money spent for travel within the United States. Travelers using AEC funds were not earmarked.	Do.
International Conference on Construction of Medium Energy Cyclotrons, Sea Island, Ga., Feb. 2–4, 1959.	6,800	Travel, foreign scientists $2,500 Secretarial, clerical, and incidentals. 1,400 Publication of proceedings 2,000 Overhead 900 Total 6,800 (AEC approved overhead for NAS.)	$2,500	Dr. Hugo Atterling, Sweden; Prof. Pierre Marmier, Switzerland; Prof. W. B. Powell, England; Prof. F. A. Heyn, the Netherlands.
24th Cold Spring Harbor Symposium on Quantitative Biology, Cold Spring Harbor, N.Y., June 3–11, 1959.	7,500	Travel and per diem of foreign participants: Travel $4,920 Administrative 500 Publication of proceedings 2,080 Total 7,500	$4,920	F. H. Morley, Canberra, Australia; A. E. Mourant, London, England; B. Rensch, Munster, Germany; Maxime, Lamotte, France; B. Kurten, Helsinki, Finland.
International Symposium on the Immediate and Low Level Effects of Ionizing Radiations, Venice, Italy, June 22–26, 1959.	10,320	$10,320	$10,320	H. J. Muller, Argonne National Laboratory; Robert A. Conard, Brookhaven National Laboratory; Harvey Patt, Argonne National Laboratory; William P. Russell, Oak Ridge National Laboratory; John S. Kirby-Smith, Oak Ridge National Laboratory; Michael A. Bender, Oak Ridge National Laboratory; Howard I. Adler, Oak Ridge National Laboratory; Liane B. Russell, Oak Ridge National Laboratory.

FISCAL YEAR 1960

International Conference on Preservation of Foods, Massachusetts Institute of Technology, Cambridge, Mass., July 28–31, 1959.	$25,000	Travel and living expenses of foreign participants: Travel $8,000 Publication of proceedings 2,500 Administrative, clerical, secretarial 14,500 Total 25,000	$8,000	Dr. A. Bacigalupo, Peru; Dr. Boroughs, Costa Rica; Dr. P. Cheosakul, Thailand; Dr. J. Kuprianoff, Germany; Dr. W. McMurray, South Africa; G. Mocquot, France; Dr. K. K. Nair, India; Dr. D. Rose, Canada; Dr. S. Soriano, Argentina; Dr. Y. Sumiki, Japan.

Topical Conference program, USAEC—Financial support—Continued

Name of conference	Total AEC support	AEC expenditures	Travel support	Name of traveler and affiliation
21st International Congress on Physiological Sciences, Buenos Aires, Aug. 9–15, 1959.	$10,000	Travel and per diem of selected U.S. participants.	$10,000	George Barlow, University of Tennessee; Robert Benjamin, University of Wisconsin; Morton Cohen, Albert Einstein College of Medicine; Hadley Conn, University of Pennsylvania; W. E. Cornatzer, University of North Dakota; Melvin Fregley, University of Florida; Irving Fritz, University of Michigan; Francisco Grande, University of Minnesota; Rodney Harvey, University of Utah; Martin Lipkin, New York University; H. W. Magoun, University of California; Carlos Martinez, University of Minnesota; Edmund Nasset, University of Rochester; Grover Pitts, University of Virginia; Allen Scher, University of Washington; Durwood Smith, University of Vermont; Gerald Spurr, University of Tennessee; Peter Witt, State University of New York; Charles Congdon, ORNL; Clarence Lushbaugh, ORNL; Frederick Sherman, Brown University.
International Conference on the Physics of Metals, Melbourne, Australia, Oct. 17–22, 1959.	4,000		$4,000	Robert Gomer, University of Chicago; B. E. Warren, Massachusetts Institute of Technology.
IAEA Conference on Application of Large Radiation Sources in Industry, Warsaw, Poland, Sept. 8–12, 1959.	25,000	Administrative costs, $2,000; travel, 23,000	$23,000	Samuel Eaton, Arthur D. Little, Inc.; Paul Aebersold, USAEC; Augustine Allen, BNL; Milton Burton, University of Notre Dame; Raymond Bushland, Agricultural Research Service; Walter Guild, Yale University; Paul Harteck, Rensselaer Polytechnic Institute; Ernest Henley, Stevens Institute of Technology; Joseph Machurek, USAEC; Michael Michaelis, Arthur D. Little, Inc.; L. S. Mims, North American Aviation; Gerald Oster, Polytechnic Institute of Brooklyn; J. W. Ranftl, General Electric Co.; Irving Rosen, Diamond Alkali Co.; H. M. Rosenstock, Wm. H. Johnston Laboratories; Joseph Silverman, State University of New York; Arnold Sparrow, BNL; Ellison Taylor, ORNL; John Turkevich, Princeton University; Walton Van Winkle, Ethicon, Inc.; Bernard Manowitz, BNL; T. Raymond Jones, USAEC; L. Reiffel, Armour Research Foundation; C. Stone, Armour Research Foundation.
International Symposium on High-Temperature Technology, Asilomar, Calif., Oct. 6–9, 1959.	4,500	Expenses shared with Air Force Office of Scientific Research, Office of Naval Research, NSF, and Office of Ordnance Research:	Lump-sum contract. AEC together with that of other contributors paid expenses. No attempt made to earmark travelers on AEC money.	None.

International Symposium on High-Temperature Technology, Asilomar, Calif., Oct. 6–9, 1959.	4,500	Expenses shared with Air Force Office of Scientific Research, Office of Naval Research, NSF, and Office of Ordnance Research: Printing cost ..... $6,850 Travel expenses, foreign guests .. 10,000 U.S. speakers travel ..... 3,150 Steering committee expenses .. 2,500 Total 22,500	Lump-sum contract, AEC together with that of other contributors paid expenses. No attempt made to earmark travelers on AEC money.	None.
International Symposium on Radioisotopes in the Biosphere, University of Minnesota, Oct. 19–23, 1959.	14,050	Travel and subsistence for participants ..... 10,000 Publication of proceedings ..... 2,800 Administrative expenses ..... 1,250 NSF likewise contributed $14,050 for this symposium.	$10,000	William Meyers, New Delhi, India; Leonard Lamberton Royal Cancer Hospital, England; Scott Russell, Radiological Laboratory, England; Arne Engstrom, Karolinska Institute, Sweden; B. G. Migicovsky, Department of Agriculture, Canada.
International Symposium on the Cell Nucleus, sponsored by the Faraday Society, Cambridge, England, Aug. 31–Sept. 1, 1959.	5,100	AEC money was used to pay for the travel and per diem of selected U.S. participants.	$5,100	Dale Steffensen, BNL; Philip Woods, BNL; F. S. Bollum, ORNL; Norman Anderson, ORNL; Ambrose Barten, ANL.
International Symposium on Bioenergetics, Brookhaven National Laboratory, Oct. 5–9, 1959.	25,000	Travel and per diem of foreign and U.S. speakers ..... $16,000 Travel of selected U.S. attendees .. 2,000 Publication of proceedings ..... 10,000 Administrative expenses ..... 2,000 Total ..... 30,000 Minus IAEA contribution ..... 5,000 Cost to AEC 25,000	11,000	Franklin Hutchinson, Yale University; Albert Szent-Gyorgyi, Marine Biology Laboratory, Woods Hole, Mass.; Irwin Gunslaus, University of Illinois; Rev. C. S. Bachoffer, University of Notre Dame; Robert Livingston, University of Minnesota; Michael Kasha, Florida State University; Donald McClure, RCA, Princeton, N.J.; William Arnold, ORNL; Theodore Forster, Tech. Hach. Stattgart, Germany; D. B. S. Garrett, Bell Laboratory, Murray Hill, N.J.; Sheldon Wolff, ORNL; Walter Kauzaman, Princeton University; John Kirby-Smith, ORNL; J. A. Bessham, LRL, University of California; John Jagger, ORNL; Gonion Tellin, LRL, University of California; Lubert Stryer, Harvard Medical School, Massachusetts; William McElroy, Johns Hopkins University; Walter Dale, Christie Hospital, England; Bert Tolbert, University of Colorado; L. H. Gevantman, USNRDL; John Platt, University of Chicago; Allan Conger, University of Florida; Richard Sitlow, Yale University; Milton Burton, Notre Dame University; David Green, University of Wisconsin; Ronald Mason, University College, England; Fritiof Sjostrand, Atomiska, Institionen-Sweden; Karl Haussar, Inst. Medizionen, Forschung, Germany; Henry Linschitz, Brandeis University; Eugene Rabionowitch, University of Illinois; Hans Gaffron, University of Chicago; F. S. Salisbury, Colorado State University; Sean McGlynn, Louisiana State University.

Topical Conference program, USAEC—Financial support—Continued

FISCAL YEAR 1961

Name of conference	Total AEC support	AEC expenditures		Travel support	Name of traveler and affiliation
International Symposium on the Comparative Effects of Ionizing Radiations, sponsored by NAS and held at the University of Puerto Rico, Sept. 15–19, 1960.	$10,000	Travel and per diem of selected speakers Administrative expenses Overhead approved by NAS	$6,330 2,007 1,663	$6,330	AEC has not been billed to date for Conference expenses although a number of individuals were approved as eligible for AEC travel support. NAS has not determined which travelers will be at AEC expense. A number of these individuals will be foreign guests.

[1] Other agencies supporting this Conference were NSF, Office of Naval Research, Air Force Office of Scientific Research. Support also came from UNESCO.

FOREIGN EXHIBIT

Mr. RABAUT. On page 229 you show a request for $325,000 for a foreign exhibit but you don't know where it will take place. It would appear that we will have covered a large percentage of the civilized world by the time we complete your definite program for 1961.

Mr. GARDNER. We now have requests in, Mr. Chairman, for Beirut and Damascus. The State Department has suggested conferences in Colombia and Chile. We have left over requests for an exhibit in Australia. We have been requested to put one in Rome. There is a possibility that there may be one in Scandinavia. We have a request left over from Greece, and we will probably be asked to participate in one in Austria.

Mr. RABAUT. Please supply for the record where the $325,000 is urgently needed. Also please put in a tabulation showing estimates and actual cost for this program for each of the last 5 years.

Mr. GARDNER. Yes, sir.

(The information referred to follows:)

AEC OVERSEAS EXHIBITS PROGRAM

In its budget request the AEC has included $325,000 for one and possibly two nuclear energy exhibits, the locations of which are to be determined at a later date. In addition to those exhibits programed and identified in the budget request, the Commission has 18 active requests for nuclear energy exhibits to be shown in 16 countries. Tentative priorities have been established in cooperation with the Department of State and the USIS but a final decision regarding site locations will not be made until the fall of 1960. The reason for postponing this decision is threefold:

1. More complete information will be available at a later date to determine the priority of locations for those exhibits requested for the summer and fall of 1961.

2. Unlike the Department of Commerce, which budgets on a no-year basis, the AEC budgets on a fiscal year basis; accordingly, funds will be needed in fiscal year 1961 to plan, contract for, and construct the one or two exhibits which will be presented during the early part of fiscal year 1962.

3. The decision to set the date for the Third International Conference on the Peaceful Uses of Atomic Energy to be held in 1962 or 1963 will not be made until September 1960. In the event the U.N. convenes this conference in September 1962, part of these unprogramed funds will be required for advance planning and fabrication of those exhibit items requiring long leadtime.

Training, education, and information program—Comparison of amount available with actual cost experience—Operating costs

[In millions of dollars]

	Amount available	Actual	Difference
Fiscal year 1958	$16.5	$15.5	−$1.0
Fiscal year 1959	20.2	16.2	−4.0

CIVILIAN APPLICATION OF ISOTOPES AND NUCLEAR EXPLOSIVES

Mr. RABAUT. Civilian application of isotopes and nuclear explosives, $11.5 million. Insert pages 230 through 241.

(The justification is as follows:)

CIVILIAN APPLICATIONS OF ISOTOPES AND NUCLEAR EXPLOSIVES—OPERATING COSTS

Program statement

Estimate, fiscal year 1961	$11,500,000
Estimate, fiscal year 1960	11,000,000
Increase	500,000

Two major programs are included under the above heading: (1) The development of industrial uses of radioisotopes and radiation, and (2) the development of civilian applications of nuclear explosives (PLOWSHARE). A summary of the budget estimates for these two programs follows:

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
1. Isotopes development program	$3,131,576	$4,000,000	$4,500,000
2. Plowshare program	2,630,821	7,000,000	7,000,000
Total	5,762,397	11,000,000	11,500,000

The isotopes development program in fiscal year 1961 will continue exploratory research and development activities initiated during fiscal year 1959 and 1960. This program, primarily of an applied research and development nature, has four phases which are integrated to provide balance to the program. These phases are aimed toward: (1) expanding the technology and utilization of isotopes in connection with industrial and commercial opportunities; (2) providing support for the specialized training of persons who can work safely with radiation; (3) encouraging private production of isotopes in anticipation of the time when private industry will supply a major portion of all radioisotopes; and (4) developing through research and development activities application of high-level or massive radiation.

The plowshare program provides for the development of the peaceful uses of nuclear explosives including research, development and testing of devices for specific applications. The fiscal year 1961 program planned will include: (1) research; (2) power, isotopes and basic physics experiment; (3) high explosive experiments designed to obtain scaling, effects and safety data; (4) investigation of applications relative to the recovery of oil; and (5) work toward obtaining information on uses of nuclear explosives for excavation. The primary responsibility for the conduct of the technical aspects of this program rests with the Lawrence Radiation Laboratory at Livermore, Calif.

1. ISOTOPES DEVELOPMENT PROGRAM

Summary of estimates by category

Category	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
(*a*) Radioisotope technology development	$869,286	$1,895,000	$1,810,000
(*b*) Radioisotope technology training	940,054	275,000	450,000
(*c*) Radioisotope production and process development	501,641	846,000	765,000
(*d*) Industrial process radiation	523,921	584,000	1,165,000
(*e*) Start-up costs	73,000	0	0
(*f*) Equipment not included in construction projects	232,674	400,000	310,000
Total isotopes development program	3,131,576	4,000,000	4,500,000

JUSTIFICATION OF CATEGORIES

(*a*) *Radioisotope technology development, $1,810,000*

Radioisotopes and the physical principles by which they are used constitute a vast natural resource for scientific and technical progress in all areas of science and engineering. This program, therefore, aims to create a broad base for development of new and improved radioisotope technology having natural extension to many areas of the national economy. These diverse areas include industry, agriculture, applied medicine, etc., thus the technology is of major public interest. Many isotope methods have not reached their full potential, including such widely applicable techniques as activation analysis, radiometric methods, gamma absorption analysis, tracer technology, fluid dynamics, etc. Radioisotopes technology will be developed to permit extension to practical applications in areas such as production processing and control, water resources, industrial waste treatment, air pollution, and other technical fields.

To achieve broad development of radioisotopes technology, cooperative research and development contracts have been undertaken with several geographically distributed university centers, research laboratories, AEC national laboratories, a limited number of industrial organizations, and other Government agencies through cooperative agreement arrangements.

The major technology development program activities are:

(1) *Radiometric analysis and tracer technology, $410,000.*—Radiometric methods of analysis provide unique sensitivity and specifically for quantitatively measuring exceedingly low concentrations of materials such as environmental contaminants. Tracer techniques possess the capability for making important technical and scientific measurements not possible by other conventional methods. Efforts will be directed toward developing (*a*) isotope dilution techniques, (*b*) automatic analysis devices applying radiometric techniques, (*c*) development of new methods of analysis, (*d*) development of new sensitive detection techniques for chromatographic analysis, and (*e*) development of new radiometric titration methods.

(2) *Activation analysis, $250,000.*—Through use of neutron beams and sensitive radiation measurement systems, it is possible to perform instantaneous analysis of many materials not possible in any other way. This method currently remains undeveloped except as a laboratory tool for specialized problems. Research will be undertaken to investigate the limits of sensitivty for additional elements and means of increasing resolution by computer techniques, and to develop automatic analyzers to permit fast simultaneous analysis of complex mixtures. At present, bombardment (with thermal neutrons, only) is used extensively for analytical purposes. The possibility of using monochromatic neutrons of various energy levels for the selective determination of elements having high cross section of neutron resonance absorption will be investigated. In addition, use of pulsed neutron reactions will be investigated. Activation analysis technology also will be developed for analytical determinations involving stream pollution, water resources, air pollution, biological material, agricultural products, soil, textile identification, food contamination, and identification of food additives.

(3) *Radioisotope fluid dynamics techniques, $250,000.*—Development of radioisotope hydraulic and fluid dynamics techniques will provide widely useful tools for exploration and conservation of water and other natural resources. Conventional procedures are not sufficiently sensitive and specific for solution of many of these urgent public problems. Potentially important uses include measurements of movement and loss of (1) water in rivers, underground streams and canals, and (2) fluids in processing systems. Development of these radioisotope techniques will also be of great value in such problems as water pollution, harbor sedimentation, and littoral drift of beaches.

(4) *Isotopic power and ionization technology, $300,000.*—Research and development carried out in fiscal year 1959 demonstrates the technical feasibility of use of strontium 90 as a fuel for isotopic power units. In fiscal year 1960, a remote, automatic weather station powered by a strontium 90 heat generator will be built jointly by the AEC and the Weather Bureau. Similar cooperative efforts will be undertaken with other Federal and State agencies for meeting problems of general public interest. Research and development will be undertaken on other fission products to examine their feasibility for isotopic power. Feasibility investigations will be initiated for utilization of large quantities of fission products to regenerate the reactants in chemical fuel cells for small power units.

Radioisotopes, particularly the fission product krypton 85, possess the potential ability to eliminate serious static problems in hospital operating rooms, communications centers, and industrial processes. In addition, radioisotopes have the capability of improving the firing characteristics of electron tubes, radar sets, and spark devices. Research and development will be carried out on radioisotope source development and technology related to the ionization phenomena.

(5) *Isotope measurement systems, $200,000.*—Development of low-level counting techniques and measurement systems will open new means of using very small quantities of radioisotopes in ground water studies, chemical processes, and general tracer techniques. New scintillation systems and solid state detection techniques will be researched. Successful developments should lead to application of low-level tracing techniques to production and process control as well as to sewage and industrial water pollution problems which hold vast potential for public benefit.

(6) *Gamma absorption analysis, $200,000.*—The number of available gamma-emitting radioisotopes useful as sources of radiation for gamma absorption analysis is extremely limited. Further development of gamma absorption analysis technology using low-energy photons depends upon development of secondary X-ray radiation sources. Development of such low-energy radioisotopic sources will provide new research and engineering tools for nondestructive testing of metals, biological materials, and chemicals, as well as providing a radiation source for medical radiography units. New means for producing these low-energy photons will be studied to determine necessary characteristics to meet specific applications. Beta ray sources, electron capture sources, and secondary X-ray sources will be developed to support these promising techniques.

(7) *Nondestructive testing, $200,000.*—Radioisotope techniques for nondestructive testing can play an increasingly important role in missile construction, aircraft, ships, and highway structures, as well as many other important industrial applications. The opacity of materials to thermal neutrons, irrespective of the sequence of atomic number, holds much promise in the field of nondestructive testing. Principal needs for research and development include (1) neutron sources with suitable energies, and (2) sensitive detectors that will provide proper resolution of the neutron fluxes from the material being tested. Fission products, such as Cs^{137}, Pm^{147}, Sr^{90}, and Kr^{85} are potentially very important in this connection due to their variety of radiation energy ranges, but much additional work needs to be done on source development and techniques for measuring the transmitted radiation signals.

(*b*) *Radioisotope technology training, $450,000*

The objectives of radioisotopes technology training recognize (*a*) the inherent impossibility of encouraging widespread and new applications of radioisotope techniques in the absence of industrial manpower trained to exploit these procedures safely and routinely, and (*b*) the importance of education in dispelling the unwarranted fear and concern which limit the widespread peaceful applications of atomic energy.

(1) *Industrial radioisotope training, $100,000.*—The 6-week training course in the industrial applications of radioisotopes at the Oak Ridge Institute of Nuclear Studies will be offered four times during fiscal year 1961 for industrial scientists and engineers. In addition, two short summer offerings will provide concentrated attention to advanced industrial research and applications. Each course will accommodate 24 students. A registration fee of $25 is charged each participant. The estimated student load, costs, and revenues for this course are as follows:

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
Number of students	51	72	120
Operating cost	$73,000	$100,000	$100,000
Revenues	$1,275	$1,900	$3,000

NOTE.—The ORINS program will continue to be the Commission's major onsite effort in training of industrial scientists and engineers.

(2) *Radioisotope training assistance, $150,000.*—Undergraduate, graduate, and industrial courses in radioisotopes and radiation technology will be supported through equipment grants to colleges and universities. Minimal assistance will be provided a small number of colleges and universities to stimulate lecture and laboratory instruction in radioisotope characteristics and techniques. Overall objectives of this education assistance program continue to be—

(*a*) Provision of increased regional training opportunities for industrial scientists and engineers;

(*b*) Availability of personnel adaptable with minimum additional training power reactor technology and other nuclear development activities; and

(*c*) Establishment of a reservoir of trained manpower to meet the growing needs of industry, Government, and the military.

(3) *AEC–NSF summer institutes, $100,000.*—The cooperative AEC–NSF program initiated in fiscal year 1960 will be continued during fiscal year 1961. Radioisotope training institutes for college faculty in the physical sciences and engineering will accommodate approximately 100 participants through approximately five 8-week summer institutes. AEC support for this program covers operating funds for the institutes, and the National Science Foundation provides a stipend and travel expenses for the participants. This specialized training in radioisotope techniques and handling procedures increases considerably the quality of instruction and capabilities of the many smaller college and university faculty. Furthermore, it assures more effective use of specialized training equipment that might be provided to the participant's institution through the various assistance programs sponsored by the Federal Government.

(4) *Other radioisotope training activities, $100,000.*—A limited activity for the development of training aids for colleges and universities will be continued. There is a recognized need for well-planned training aids specifically oriented to radioisotope techniques applicable to industrial research and development problems.

(*c*) *Radioisotope production and process development, $765,000*

Fission product utilization is becoming more widespread with the passage of time. New applications and increased utilization of radioisotopes have created a need to increase the availability of new or existing products. Production demands on the fission product pilot plant and the demands made for greater yields and high purity processes to separate and purify the various fission products, exemplify the need to pursue the radioisotope production and process development program.

(1) Radioisotope production development programs in fiscal year 1961 will include contracts with private research and development organizations for the development of prototype equipment and production processes, products, and markets to promote the economic utilization of fission product isotopic sources. A total of $50,000 is required in fiscal year 1961 for this work.

(2) Fiscal year 1961 radioisotope process development programs will place major emphasis on the development of processes for the recovery and purification of fission products from the many different types of power reactor fuel and AEC production reactor fuel reprocessing effluents. The fiscal year 1961 estimate of $250,000 includes provision of experimental apparatus for the demonstration of fission product recovery processes in conjunction with the Oak Ridge National Laboratory reactor fuel reprocessing pilot plant.

(3) Separation and purification methods will be developed and demonstrated using solvent extraction, ion exchange, electroplating and electromigration in fused salts. The long range objective of these studies is the evolution of an integrated essential material-fission product recovery scheme having advantages that include reduction of power costs, increased availability of low cost fission products and optimized waste disposal. Properties of fission products and other isotopic source compounds will also be studied to define their physical and chemical characteristics. Measurements will be made of radiation fields and shielding requirements so that safe containment of isotopic sources can be effectively achieved with minimum weight shields. Investigations will also be made of the yields of reactions, such as (n,p), (n,r) and (n,2n) to produce new radioisotopes in high flux reactors that are valuable tools for agricultural, biological, medical, and industrial research. This work will require an estimated $465,000 in fiscal year 1961.

(*d*) *Industrial process radiation, $1,165,000*

Programatic emphasis will be on utilization of fission product wastes, utilization of radiation for conservation of natural resources, and development of processes for which nuclear reactors would be economic sources of radiation.

(1) Studies to provide physical data on the radiation engineering characteristics of radiation sources are essential to ultimate development of pilot plant and eventually production facilities for chemicals and other materials using massive quantities of radiation. This work will increase during fiscal year 1961. The results of this work will be correlated in a radiation engineering handbook. This work has the purpose of establishing radiation as a source of energy for chemical processing similar to other sources of energy. It includes the evaluation of hazards inherent in the use of large megacurie radiation sources such as fission product cesium 137, heat generation problems, methods of handling, fabricating and encapsulating and testing many different kinds of isotopic sources. A total of $395,000 is included in the estimate for this work.

(2) Research work on selected chemical reactions will be performed concurrently with radiation engineering research at an increased level. It will include investigation of feasible radiation processes to improve the economics of the processes. Research on the primary and secondary products of radiation interaction with matter will be expanded. Contract activities will be aimed at learning to predict radiation reactions and eventually, through judicious choice of conditions, to "tailor-make" chemicals. This work will require an estimated $370,000 in fiscal year 1961.

(3) Efforts initiated in fiscal year 1960 on the use of nuclear reactors as sources of ionizing radiation will continue. Experimental work to establish technical feasibility and investigate the process engineering problems related to the use of reactors for chemical processing will be conducted.

Chemonuclear reactor radiation process design studies also will be carried out.

Studies to date have indicated that there are a number of different chemical reactions that might be performed using reactor radiation. These include both liquid and gaseous systems. Production of nitric acid by irradiation of air in a nuclear reactor is an example of a gaseous system.

Several different types of reactors might be used to carry out these reactions depending on processing requirements. Possible reactor systems include—

(*a*) Fission fragment systems wherein the reactor fuel is in the form of thin fibers or dust, thus permitting the fission fragments to escape from the fuel and import their energy to a chemical system.

(*b*) Fission gamma systems wherein chemicals to be processed are passed through the reactor in such a way that they absorb the reactor's gamma, and in some cases, neutron radiation power.

(*c*) Circulating loop systems wherein an easily radioactivated material is continuously piped through the reactor and the radiation utilized by exposing chemical systems to the activated material as it circulates outside the reactor.

A number of detailed studies aimed at evaluating specific reactions and types of reactions coupled with appropriate reactor schemes are necessary. These will provide a firmer basis than has been available for evaluating the economic potential for chemonuclear reactor radiation processes. Optimization of reactors for electric power or process steam presents far different requirements than optimization for radiation power. Consequently, there presently exists no true basis for economic evaluation of chemonuclear reactor radiation processels. Also, design studies will bring into better focus the engineering problems that will arise and need to be solved before actual construction of a chemonuclear reactor can be considered. These include such problems as:

(*a*) Removal from reactor produced products of any radioactivity they might contain.

(*b*) Maximizing the amount of reactor power which is utilized in the form of ionizing radiation.

(*c*) Achieving radiation process operating requirements of temperature, pressure, throughput, physical state (*i.e.*, gas or liquid), etc.

The estimate includes $100,000 for this work in fiscal year 1961.

(4) During fiscal year 1960 the Commission initiated a program of research and development on low-dose radiation processing of foods to extend the refrigerated shelf life of food products such as meat, fish, vegetables, and fruits.

Program activities in fiscal year 1961 will include completion of startup efforts initiated in fiscal year 1960 to (*a*) collect and analyze research and development work to date relevant to the low-dose radiation processed foods program, (*b*) identify specific food products promising advantages through low-dose radiation processing, (*c*) initiation of selected research projects, (*d*) design of irradiators required for conduct of the program, and (*e*) provision of small research irradiators required for carrying out fundamental work.

Radiation study agreements will also be made whereby irradiation service will be furnished without cost to qualified private organizations who in return will carry out necessary laboratory evaluations of low-dose radiation processed food without charge and will make the results of their studies generally available. The estimate includes $300,000 for this work in fiscal year 1961.

(e) Equipment not included in construction projects, $310,000

Twenty thousand dollars is required at the Oak Ridge Institute of Nuclear Studies for the purchase of specialized laboratory equipment to be used in conjunction with the basic courses on industrial utilization of radioisotopes. Two hundred and twenty-five thousand dollars is required to maintain the AEC's isotope production program at ORNL, and $65,000 to support the high-intensity radiation development program at BNL.

Following is a summary of operating costs and related equipment costs for fiscal year 1961:

Contractor	Other operating costs	Equipment costs
Oak Ridge Institute of Nuclear Studies	$100,000	$20,000
Oak Ridge National Laboratory	715,000	225,000
Brookhaven National Laboratory	395,000	65,000
All other	2,980,000	0
Total	4,190,000	310,000

2. Plowshare Program

Summary of estimates by category

Category	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
(*a*) Research and development	$1,071,595	$3,200,000	$3,200,000
(*b*) Feasibility experiments	1,355,621	3,600,000	3,700,000
(*c*) Equipment not included in construction projects	203,605	200,000	100,000
Total	2,630,821	7,000,000	7,000,000

JUSTIFICATION OF CATEGORIES

(a) Research and development, $3,200,000

The amount requested will provide the research effort to support a program to study the utilization of nuclear explosives for peaceful uses. This research encompasses feasibility studies, device development, and investigation of effects. Feasibility studies are conducted to identify new areas in which nuclear explosives may be utilized for peaceful purposes. Device research is directed toward the development of nuclear explosives designed specifically for peaceful rather than military uses by incorporating features such as minimum use of critical materials, low yield of radioactive debris and minimum utilization of classified design information. The effect study will support all potential applications now being investigated. More specifically, it includes the measurement of properties of materials, such as their melting points and failure strengths, the development of techniques and instruments for measuring these properties, and development of special computer techniques. Particular emphasis will be given in the budget year to the analysis of raw data obtained from the high explosive and Gnome experiments.

(b) *Feasibility experiments, $3,700,000*

The activities included in this category are designed to demonstrate the peaceful applications of nuclear explosives. The fiscal year 1961 budget provides for work on (1) a power, isotopes, and basic physics experiment (Project Gnome); (2) high-explosive experiments designed to obtain scaling, effects, and safety data; (3) work on oil exploratory project; and (4) work toward a civil engineering investigation experiment.

In the Project Gnome experiment, it is proposed to detonate a nuclear device in the range of 10-kiloton yield in a salt formation in the Carlsbad area of southeastern New Mexico. The experiment is designed as a contained explosion to provide information on the possibility of generating useful power through utilizing the heat released from such a detonation; to investigate the possibility of the production and recovery of isotopes, which in principle can be produced by the high-energy particles from a nuclear explosion; and to carry out certain basic physics experiments not feasible by other means.

The high explosives experiments initiated in fiscal year 1960 will continue during the budget year. The project consists of several high explosive detonations in different media to obtain the following types of data which will aid in designing the nuclear experiments: (1) The relationship of crater dimensions to depth of burial; (2) effects of simultaneously detonated charges; and (3) empirical verification of theoretical scaling laws. Through the use of high explosive experiments, much essential data can be secured which otherwise could be acquired only from nuclear detonations.

Investigating the application of nuclear explosives to oil recovery is the objective of the oil exploratory project. Two experiments are being investigated for possible accomplishment: (1) An experiment to obtain data on the use of nuclear explosives in the recovery of oil from tar sands, and (2) an HE experiment to obtain safety data on detonations in oil shale.

The civil engineering project is planned as an experiment to obtain engineering and scientific information applicable to the use of nuclear explosives for excavation purposes. The site being investigated for the first experiment (Project Chariot) is on the coast of Alaska near Cape Thompson. From the experiment would be secured data on the relation of yield to crater size; the effects of simultaneous detonations on crater dimensions; depth of burial to distribution of debris; crater dimension to characteristics of the media; and ecological effects, if any, from a partially contained detonation.

(c) *Equipment not included in construction projects, $100,000*

The amount budgeted under this category is to provide for necessary field support and scientific measurement equipment. Equipment costs related to other operating costs in fiscal year 1961 are as follows:

Contractor	Operating costs	Equipment costs
Lawrence Radiation Laboratory	$3,500,000	$100,000
All other	3,400,000	0
Total	6,900,000	100,000

Mr. RABAUT. Testimony given the committee in the past concerning the isotope program is to the effect that industry is putting vast sums into isotope development for application in private enterprise. Why is it necessary for the Government to continue to sell this program to the tune of $4.5 million?

Dr. AEBERSOLD. Last year your committee asked 12 questions of a basic and challenging nature about the relative role of Government and industry in this activity. We have had these questions that your committee posed, and our answers, reviewed by our Advisory Committee on Isotopes and Radiation Development, by executives of the National Association of Manufacturers, by executives of the Atomic Industrial Forum and by various industry groups. We found, I

believe, general agreement that there is a need for Government support in this area. The funds that private enterprise puts into this program are largely in the end uses. We are trying to develop and extend the basic techniques, the principles of the broad field of isotope and radiation technology, as an integral part of the whole field of nuclear technology.

I can supply for the record figures on what our estimates are of the approximate investments of private enterprise, but as I indicated industry's investments are largely on final applications, on routine uses like isoltope gages. We estimate that the investment in isotope gages of all kinds is over $25 million. In isotope radiography, it is over $5 million. So in the routine uses of that type there is probably will over $30 million invested. In applied research uses, we estimate from the number of isotope labs and related equipment in use by industry that another investment of around $25 million is involved. In the gamma ray radiation field, about 100 companies have laboratories and irradiators. We estimate that this represents an investment of around $5 million. This would make a total of around $30 million in the research areas.

Mr. RABAUT. You said something about the same as last year.

Dr. AEBERSOLD. Approximately. But it goes beyond that. Industry's investment is aimed more at final end use more than in the development of principles and techniques.

Mr. RABAUT. Do you need this much money for that? I should think that the effect of the use of these isotopes in industry would be something that industry would be very interested in and would pick up fast, and see how it applies to them. Now, they may need some instruction on it in the beginning, but it does seem to me that the Government could start reducing its program, at least the sales end of it.

Dr. AEBERSOLD. Our activity includes four subprograms. One is that we are responsible for production of all isotopes for all uses, medical, agricultural, scientific, industrial, and even for military uses. A large item of our budget, about a million dollars, is for development of new isotope production methods, particularly for useful fission products. Another large item is the development of the board field of high-intensity radiation. This is an area which requires the use of very large sources of radiation and industry has not worked out the techniques for doing this. For this purpose we have a laboratory being built at Brookhaven called the High Intensity Radiation Development Laboratory, which will be in construction very soon. Development of radiation uses is an area in which the Government can make a very important contribution.

NEW APPLICATIONS

Mr. RABAUT. What new applications of isotopes have been developed with Government funds, and what new applications have been developed with private funds since last year? You can supply that for the record.

(The material referred to follows:)

Much of the isotope technology we are developing will not only make scientific and engineering contributions helpful to industry but will bear directly on problems of public concern. Radioisotopes techniques are being investigated

for use in areas of water resources, weather, air pollution, and industrial waste treatment and disposal.

Major development activities initiated during the past year include a cooperative program with the Weather Bureau to build a radioisotope-powered, unmanned weather station to automatically transmit weather information from such remote areas as the Arctic. This will make possible collection of weather data from areas of the world where it was previously impossible, and ultimately contribute to a major advance in the science of weather predictions.

Two instruments utilizing radioisotopes have now been developed under the OID program for analyzing the upper atmosphere for ozone and moisture. These instruments will be test flown in an Air Force weather ballon this month. This is an AEC, Weather Bureau, Air Force program to learn about the effects of ozone on long-range weather.

Smog control groups have emphasized the need for automatic, sensitive, analyzers which permit quick collection of data and implementation of control procedures. Under the isotopes program, we have developed the prototype of a unique analyzer using the fission product gas krypton 85 to measure smog constituents such as sulfur dioxide and ozone. A new principle of instrument analysis has been made available for fighting this national problem.

Radioisotope chemical procedures have been developed for cement which eliminates time-consuming steps. The American Society of Testing Materials has offered this as a tentative procedure for analyzing cement. Development of nuclear techniques for determining more efficient mixing of cement is in progress. The Bureau of Public Roads has encouraged these developments as beneficial to the national highway program.

Radioisotopes offer unique tools for increased understanding of underground flow of water, and many more water resource factors such as rainfall, runoff, ground water recharge, and waste discharge. We have been working with the U.S. Geological Survey and other groups in developing a systematic study of how nuclear techniques can be used in solving water resource problems.

Dr. AEBERSOLD. I would like to call attention to a special report which was made by the AEC to Congress, entitled "Isotopes in Science and Industry." This reviews the progress in medicine, agriculture, and science as well as in industry. This is a large report so I can supply just a condensation of those areas covered by our program.

Mr. RABAUT. You can supply what you think is necessary for the record. I understand we have one with the committee now. You may give us a condensation of that for the record.

(The material referred to follows:)

The special report reviews in detail the contributions that radioisotopes and radiation are making to the sciences, agriculture, medicine, and industry. Discussed in the report is the impact of radioisotope use: on medical diagnosis and therapy; on research in the physical, chemical, and life sciences; on development of new industrial applications; and on the development of techniques and principles for using high intensity ionizing radiation as a scientific and industrial tool.

In the development of new technology for radioisotopes and radiation, the Commission has placed leading emphasis upon work that promises public benefit. The report reviews several of these types of activities, many of which are being undertaken on a cooperative basis with other Government agencies. Other AEC-supported work is being carried out through research and development contracts with private industry, with national laboratories, and with colleges and universities. The report also outlines the AEC radioisotope production and distribution programs, which respond to nationwide medical, research, and industrial demands, and include the development of new radioisotopes needed for many research purposes.

The report discusses the need for training and education in radioisotope technology in order to provide for the much broader use of radioisotopes and radiation which is already beginning to be evident. A major consideration in such training is to provide for the safe handling and use of radioactive materials as their utilization in agricultural, medical, and industrial areas broadens.

PLOWSHARE PROGRAM

Mr. RABAUT. Your objectives for the plowshare program are the same as last year. First, to develop power by exploding a bomb underground in New Mexico; second, to get oil out of oil shale in Colorado; and, third, to dig a harbor in Alaska. Have you gotten any closer to these objectives with the $7 million you are spending this year?

Mr. KETO. Mr. Chairman, taking those in order, the Commission recently approved proceeding with the Gnome project. In the middle of March bids were issued for certain construction with regard to this project and request for bids is now out and we are hoping around the 1st of May to receive the bids and proceed with the actual construction for the Gnome project.

With regard to the oil-shale project, the second on your list, that would be perhaps in Colorado, Wyoming, or Utah. We are now proceeding and have designed a high-explosive experiment there that is scheduled to be shot in June of this year. This high-explosive experiment will give us the necessary data to position the nuclear explosive for the actual test.

With regard to the third item on your list, Mr. Chairman, and that is on Chariot, we have done a lot of technical analysis there about the geology and the hydrology of the site, and so forth, and we do feel that we have the information necessary to design the experiment.

In addition, we are proceeding on environmental studies that will enable the Commission to determine whether in fact the shot can be made.

Mr. RABAUT. How much of the $7 million have you spent?

Mr. KETO. About $4.2 million.

Mr. RABAUT. Will you use the rest of it during the balance of the year?

Mr. KETO. Yes, sir.

Mr. RABAUT. At a time when funds are urgently needed for defense and the Federal fiscal situation is so precarious, how can you justify this project which we don't really need in the foreseeable future?

Mr. KETO. I believe, sir, that the Chairman has expressed his feeling on that, that it is a very important project, and we do have very great hopes for it. I could take the same list on the Gnome project and discuss specific aspects of Gnome.

Mr. RABAUT. If you wish to enlarge on your remarks, you may do so when you get your testimony back.

Mr. KETO. Thank you very much, sir. I appreciate that.

Mr. RABAUT. Has any segment of American industry or business indicated any interest in this program?

Mr. KETO. Yes, sir.

Mr. RABAUT. Who?

Mr. KETO. The petroleum industry has expressed an interest in the oil-shale shots, sir.

Mr. RABAUT. Off the record.

(Discussion off the record.)

STATE ACCEPTANCE OF NUCLEAR EXPLOSIONS

Mr. RABAUT. Do you envision that any State or local government will accept the idea that fissionable material, with all of its accompanying hazards, should be used instead of dynamite or other tools to dig harbors, harvest oil, or make heat?

Mr. KETO. We believe that these shots can be——

Mr. RABAUT. Do you think local governments will accept the idea?

Mr. KETO. I believe that is right, they will. In the State of New Mexico, for example, we have had to the best of my knowledge no such protest on the Gnome shot, sir.

Mr. FLOBERG. Part of the purpose of these shots is to demonstrate their feasibility and safety. That is why some of the sites have been chosen as they have.

Mr. RABAUT. How can this project proceed during the test suspension period?

Mr. KETO. The United States, United Kingdom, and Soviet Union have agreed in principle on the fact that the plowshare program should be continued.

Mr. RABAUT. I thought the other day they said here there would be a problem to have such activities as this under the program.

Mr. KETO. Mr. Chairman, I believe that specific statement was directed at the development of certain types of devices that would be very helpful in the plowshare program. These devices would be very clean devices. They would be economical devices. They would be devices with a great deal of flexibility, and it would take a program of development and experimentation to develop these particular devices.

Mr. RABAUT. Do you feel the test suspension would permit this to go on?

Mr. FLOBERG. I believe it will permit it to go on, Mr. Chairman, but there is no doubt that the test suspension will have an inhibiting effect on it. In other words, the program cannot blossom as fully, as quickly if the test suspension takes place.

COMMUNITY PROGRAM

Mr. RABAUT. Now we have the community program, $10.4 million. Insert pages 242 through 257 in the record.

(The justification is as follows:)

COMMUNITY PROGRAM—OPERATING COSTS

Program statement

Estimate, fiscal year 1961	$10,204,000
Estimate, fiscal year 1960	14,632,000
Decrease	4,428,000

The community program provides for—

1. Operation and administration of the AEC controlled and operated community of Los Alamos, N. Mex., including municipal services, utilities, hospital, housing, and commercial properties.

2. Housing and operation of utilities for project-connected employees at Sandia, N. Mex.; Monticello, Utah; and Grants, N. Mex.

3. Making assistance payments to the former AEC communities of Oak Ridge, Tenn., and Richland, Wash., in accordance with the Atomic Energy Community Act of 1955, as amended (Public Law 84–221).

The principal operations of the community of Los Alamos are carried out under a cost-type contract. Commercial facilities are generally operated by private enterprise through lease or concession agreement.

Housing and utilities are provided for a small AEC community of 1,500 residents located within Sandia Base at Albuquerque, N. Mex. Limited housing is also provided for employees engaged in raw-materials program activities at Monticello, Utah, and Grants, N. Mex.

The estimates for assistance payments at Oak Ridge and Richland are based on Public Law 84–221, which provides that for a period of 10 years from the date of transfer of any municipal installations to a governmental or other entity the Commission shall make annual assistance payments of just and reasonable sums. In determining the amount and recipient of such payments, the statute states that the Commission shall consider—

(1) The approximate real property taxes and assessments for local improvements which would be paid to the governmental entity upon property within the community if such property were not exempt from taxation by reason of Federal ownership;

(2) The maintaining of municipal services at a level which will not impede the recruitment or retention of personnel essential to the atomic energy program;

(3) The fiscal problems peculiar to the governmental entity by reason of the construction at the community as a single purpose national defense installation under emergency conditions; and

(4) The municipal services and other burdens imposed on the governmental or other entities at the community by the United States in its operations in the project area.

The decrease in gross cost levels of $4,428,000, as reflected in the summary table, is attributable primarily to the reduction in cost of operation and administration as a result of the disposal of the communities of Oak Ridge, Tenn., and Richland, Wash. However, the reduction in costs for these communities is partially offset by increased costs at Los Alamos, N. Mex.

While the gross cost level decreases $4.4 million, the net cost to the Commission after application of revenues increases $0.4 million from fiscal year 1960 and increases $1.2 million from fiscal year 1959. This increase in net operating costs is attributable to the disposal of Oak Ridge and Richland with the resultant loss of income, and higher costs at Los Alamos due principally to wage increases and increased school costs.

The revenues from community operations are included under the program revenues applied as a reduction in the operating expenses appropriation. A summary comparison of community operating costs and revenues is shown in the table on the next page. Tables of operating costs and revenues by category for each community are included in the pages following:

Summary of community costs and revenues

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
Operating costs:			
Oak Ridge, Tenn	$7,093,455	$6,615,000	$3,000,000
Richland, Wash	4,028,677	2,308,000	1,256,000
Los Alamos, N. Mex	4,968,841	5,295,000	5,535,000
Sandia, N. Mex	88,782	395,000	395,000
Monticello, Utah, and Grants, N. Mex	29,846	19,000	18,000
Total operating costs	16,509,601	14,632,000	10,204,000
Revenues (budgeted under revenues applied):			
Oak Ridge, Tenn	4,913,611	4,006,000	0
Richland, Wash	2,819,294	945,000	80,000
Los Alamos, N. Mex	4,959,090	5,010,000	5,090,000
Sandia, N. Mex	458,684	515,000	515,000
Monticello, Utah, and Grants, N. Mex	37,944	25,000	12,000
Total revenues	13,188,623	10,501,000	5,697,000
Net operating costs:			
Oak Ridge, Tenn	2,179,844	2,609,000	3,000,000
Richland, Wash	1,209,383	1,363,000	1,176,000
Los Alamos, N. Mex	9,751	285,000	445,000
Sandia, N. Mex	−69,902	−120,000	−120,000
Monticello, Utah, and Grants, N. Mex	−8,098	−6,000	6,000
Total net operating costs	3,320,978	4,131,000	4,507,000

OAK RIDGE, TENN.

The fiscal year 1961 estimate for Oak Ridge provides principally for assistance payments to the incorporated city of Oak Ridge in accordance with chapter 9 of the Atomic Energy Community Act of 1955, as amended, Public Law 84–221. The estimate is based on the following assumptions:

1. The population of Oak Ridge will remain at the present level of approximately 28,000 through fiscal year 1961.

2. Roads and streets were transferred to the incorporated city on June 26, 1959, but will be maintained by AEC through June 30, 1960. Schools were transferred on December 31, 1959. (Under Tennessee State laws, funds for school aid from State and county sources will not be available to the Oak Ridge city school system in fiscal year 1961.) Transfer of other facilities such as the water, sewerage and electrical distribution systems will be made to the city by July 1, 1960. Termination of all phases of community disposal will not be completed for approximately 6 months after July 1, 1960.

3. Transfer of the new Oak Ridge Hospital under Public Law 84–221 will be made to the Oak Ridge Hospital of the Methodist Church, Inc., at the beginning of fiscal year 1961. No assistance payments under Public Law 84–221 are anticipated.

4. All property will be sold by the end of fiscal year 1961. (See table II.)

Additional details are presented in tables I and II on succeeding pages.

TABLE I.—*Oak Ridge, Tenn.*

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
1. Gross costs:			
(a) Municipal	$3,737,334	$2,319,000	0
(1) Schools	2,445,574	1,093,000	0
(2) Other	1,291,760	1,226,000	0
(b) Utilities	825,366	855,000	0
(c) Real estate operations	784,388	230,000	0
(d) Hospital	1,393,773	1,405,000	0
(e) Equipment	168,018	194,000	0
(f) Community disposal	214,576	1,612,000	$3,000,000
(1) Assistance payments to municipalities	0	1,333,000	2,895,000
(2) Costs other than assistance payments	214,576	279,000	105,000
Total gross costs	7,093,455	6,615,000	3,000,000
2. Revenues (budgeted under Revenues Applied):			
(a) Municipal	898,684	929,000	0
(b) Utilities	1,495,561	1,557,000	0
(c) Real estate operations	1,224,617	229,000	0
(d) Hospital	1,294,749	1,291,000	0
Total revenue	4,913,611	4,006,000	0
3. Net costs:			
(a) Municipal	2,838,650	1,390,000	0
(1) Schools	2,130,128	938,000	0
(2) Other	708,522	452,000	0
(b) Utilities	−670,195	−702,000	0
(c) Real estate operations	−440,229	1,000	0
(d) Hospital	69,024	114,000	0
(e) Equipment	168,018	194,000	0
(f) Community disposal	214,576	1,612,000	3,000,000
(1) Assistance payments to municipalities	0	1,333,000	2,895,000
(2) Costs other than assistance payments	214,576	279,000	105,000
Net costs	2,179,844	2,609,000	3,000,000

U.S. Atomic Energy Commission—Commission-Owned "Private Use" Properties for Sale Under Public Law 221

Table II.—*Oak Ridge, Tenn.*

	Inventory, July 1, 1956	Number of units remaining unsold		
		Actual, June 30, 1959	Estimated, June 30, 1960	Estimated, June 30, 1961
Residential:				
Single and duplex housing	[1] 4,360	8	0	0
Apartment buildings	[2] 258	101	0	0
Dormitories	7	6	0	0
Vacant and privately developed land	1,604	735	300	0
Subtotal residential	6,229	850	300	0
Commercial and nonresidential	239	65	0	0
Grand total	6,468	915	300	0

[1] Includes 3,526 single-family houses and 834 duplex houses (1,668 family units).
[2] 2,080 family units.

RICHLAND, WASH.

The fiscal year 1961 estimate for Richland provides for assistance payments in accordance with chapter 9 of the Atomic Energy Community Act of 1955, as amended, Public Law 84–221. The estimate is based on the following assumptions:

1. The population of Richland will remain at the present level of approximately 27,000 through fiscal year 1961.

2. Police, fire, engineering, and city clerk were transferred to the city of Richland on June 1, 1959; all other municipal functions, including conservation of health and welfare, were transferred on September 1, 1959. Utilities, including water, waste removal, and sewerage, were transferred on October 1, 1959; the electric utility was transferred on November 1, 1959.

3. The estimated assistance payment of $68,000 to the Kadlec Methodist Hospital in fiscal year 1961 will bring the total assistance payments to the amount of $393,000 which is the maximum agreed to in the memorandum of understanding between AEC and Kadlec Methodist Hospital dated June 6, 1958. No further assistance payments after fiscal year 1961 are anticipated.

4. The assistance payments to the Richland School District are based on estimated rates under Public Law 81–874 entitlement, assuming full occupancy of Richland housing in view of NPR construction program.

5. All property will be sold by the end of fiscal year 1961. (See table II.)

Additional details are presented in tables I and II on succeeding pages.

TABLE I.—*Richland, Wash.*

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
1. Gross costs:			
(a) Municipal	$1,598,189	$233,000	0
(b) Utilities	580,527	197,000	0
(c) Real estate operations	503,265	177,000	0
(d) Equipment	62,902	0	0
(e) Community disposal	1,283,794	1,701,000	$1,256,000
(1) Assistance payments to municipalities	0	752,000	524,000
(2) Assistance payments to schools	1,034,068	850,000	664,000
(3) Assistance payments to hospitals	103,646	52,000	68,000
(4) Costs other than assistance payments	146,080	47,000	0
Total gross costs	4,028,677	2,308,000	1,256,000
2. Revenue (budgeted under revenues applied):			
(a) Municipal	560,936	267,000	0
(b) Utilities	1,224,535	378,000	0
(c) Real estate operations	1,033,823	300,000	80,000
Total revenue	2,819,294	945,000	80,000
3. Net costs:			
(a) Municipal	1,037,253	−34,000	0
(b) Utilities	−644,008	−181,000	0
(c) Real estate operations	−530,558	−123,000	−80,000
(d) Equipment	62,902	0	0
(e) Community disposal	1,283,794	1,701,000	1,256,000
(1) Assistance payments to municipalities	0	752,000	524,000
(2) Assistance payments to schools	1,034,068	850,000	664,000
(3) Assistance payments to hospitals	103,646	52,000	68,000
(4) Costs other than assistance payments	146,080	47,000	0
Net costs	1,209,383	1,363,000	1,176,000

U.S. ATOMIC ENERGY COMMISSION—COMMISSION-OWNED "PRIVATE USE" PROPERTIES FOR SALE UNDER PUBLIC LAW 221

TABLE II.—*Richland, Wash.*

	Inventory July 1, 1956	Number of units remaining unsold		
		Actual June 30, 1959	Estimated June 30, 1960	Estimated June 30, 1961
Residential:				
Single and duplex housing	[1] 4,805	169	0	0
Apartment buildings	[2] 17	17	0	0
Dormitories	25	2	0	
Vacant and privately developed residential land	253	61	0	0
Subtotal residential	5,100	249	0	0
Commercial and nonresidential	325	313	87	0
Grand total	5,425	562	87	0

[1] Includes 3,787 single-family houses and 1,018 duplex houses (2,036 family units).
[2] 144 family units.

LOS ALAMOS, N. MEX.

Los Alamos, N. Mex., a community of approximately 13,750, is operated by the Atomic Energy Commission to support the research and development program of the Los Alamos Scientific Laboratory. The total cost of providing the residents with municipal services, schools, utilities, housing, and medical care is estimated to be $5,535,000 or $240,000 more than the current year. The basic factors contributing to this increase are the growing school population, rising wage level of community employees, and additional housing maintenance expenditures.

The AEC contribution to school operations will be increased by $85,000 in fiscal year 1961. This reflects enrollment growth (4,180 to 4,350), merit salary increases, adjustment of the basic salary schedule, and increased staff for specialized high school facilities which will be available September 1, 1960. The only other category showing a significant change is real estate operations. This represents additional wage payments for maintenance personnel, adoption of a 4-year painting cycle, and extensive roof repairs. The rising costs will be offset in part by higher revenues resulting from the housing modification program now underway, greater utilization of medical facilities, and rising utility consumption.

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
1 Gross costs:			
(a) Municipal	$1,559,153	$1,745,000	$1,860,000
(1) Schools	628,509	765,000	850,000
(2) Other	930,644	980,000	1,010,000
(b) Utilities	839,923	875,000	900,000
(c) Real estate operations	1,630,944	1,740,000	1,840,000
(d) Hospital	757,947	775,000	810,000
(e) Equipment	180,874	160,000	125,000
Total gross costs	4,968,841	5,295,000	5,535,000
2. Revenue (budgeted under revenues applied):			
(a) Municipal	17,304	16,000	16,000
(b) Utilities	1,385,344	1,395,000	1,425,000
(c) Real estate operations	2,978,022	3,013,000	3,025,000
(d) Hospital	578,420	586,000	624,000
Total revenue	4,959,090	5,010,000	5,090,000
3. Net costs:			
(a) Municipal	1,541,849	1,729,000	1,844,000
(1) Schools	628,509	765,000	850,000
(2) Other	913,340	964,000	994,000
(b) Utilities	−545,421	−520,000	−525,000
(c) Real estate operations	−1,347,078	−1,273,000	−1,185,000
(d) Hospital	179,527	189,000	186,000
(e) Equipment	180,874	160,000	125,000
Net costs	9,751	285,000	445,000

SANDIA, N. MEX.

Sandia constitutes a small AEC community of 1,500 residents located within Sandia Base at Albuquerque, N. Mex. Sandia Corp., an AEC prime contractor, operates and maintains the community. Water, electricity and gas are supplied through the facilities of the Department of Defense. Total program costs and revenues are expected to remain at the current year level.

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
1. Gross costs:			
(a) Municipal	$92,741	$90,000	$90,000
(b) Utilities	41,921	50,000	50,000
(c) Real estate operations	235,691	235,000	235,000
(d) Equipment	18,429	20,000	20,000
Total gross costs	388,782	395,000	395,000
2. Revenue (budgeted under revenues applied):			
(a) Utilities	66,147	67,000	67,000
(b) Real estate operations	392,537	448,000	448,000
Total revenues	458,684	515,000	515,000
3. Net costs:			
(a) Municipal	92,741	90,000	90,000
(b) Utilities	−24,226	−17,000	−17,000
(c) Real estate operations	−156,846	−213,000	−213,000
(d) Equipment	18,429	20,000	20,000
Net costs	−69,902	−120,000	−120,000

MONTICELLO, UTAH, AND GRANTS, N. MEX.

The fiscal year 1961 cost estimate provides for operating rental housing at Monticello, Utah, and Grants, N. Mex.

The housing at Monticello was provided for employees connected with the processing mill which was closed on January 15, 1960. Based on current planning, it is anticipated that the housing at Monticello will be put up for disposal during the latter part of fiscal year 1960. The fiscal year 1961 estimates provide for maintaining the houses until disposal. Revenues in fiscal year 1961 decrease because of reduced occupancy due to the closing of the mill.

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
REAL ESTATE OPERATIONS			
Gross costs	$29,846	$19,000	$18,000
Revenues (budgeted under revenues applied)	37,944	25,000	12,000
Net costs, real estate operations	−8,098	−6,000	6,000

Mr. RABAUT. Briefly review this program, particularly with reference to the disposition of Oak Ridge and Richland and the cost increases in Los Alamos.

General LUEDECKE. Mr. Chairman, Mr. Quinn, of the Production Division will handle this.

Mr. QUINN. So far as community disposal is concerned, Mr. Chairman, as the committee knows, we are in the final stages of disposition of the Government-owned property in the community and the assumption by the cities of self-government. As of the end of March, of the properties to be sold, 96 percent in Richland have been sold and 92 percent at Oak Ridge. We anticipate that by the end of fiscal year 1961 all such property will be sold.

Mr. RABAUT. What is included in the remaining percentage to be sold?

Mr. QUINN. At Oak Ridge the only remaining items to be sold are residential lots. At Hanford there are a number of items: some commercial property, some residential lots, some industrial property. Most of the Government-owned housing has been sold.

Mr. RABAUT. What is the situation with the public utilities?

Mr. QUINN. As far as the utilities are concerned, at Richland all of the utilities have been transferred to the community. At Oak Ridge they will have been transferred by the end of this fiscal year.

Mr. RABAUT. What about Los Alamos?

General LUEDECKE. General Starbird will speak to that.

General STARBIRD. We have an advance in the operating cost at Los Alamos of $240,000 during this coming year over the prior year. At the same time, there is an increase of revenues expected of about $80,000. However, to go back to the increase in cost, they come about in two categories. In the first place, the schools go up by about $85,000 of the $240,000. That is brought about primarily because of the increased number of children up there. The number of children attending school has gone up something over 200 during the coming year. As far as the remainder of this increase, that is primarily in the cost of operating the housing. Specifically, it is primarily in the added maintenance and repair of the housing that is there. We are having to paint a few more houses each year than we had to paint earlier. Also, we have some roofing problems that are on the increase. So, basically, they are just a series of small increases.

Mr. RABAUT. You don't think these items will keep on increasing?

General STARBIRD. I hope not, sir; but, after all, prices are going up a little bit.

Mr. RABAUT. Yes. Please furnish a comparison of your costs for the past 5 years.

Community program—Comparison of congressional submission with actual cost experience

[In millions of dollars]

	Amount available	Actual	Difference
Fiscal year 1955	$23.5	$18.9	−$4.6
Fiscal year 1956	22.8	18.8	−4.0
Fiscal year 1957	18.0	17.8	−.2
Fiscal year 1958	16.5	17.7	1.2
Fiscal year 1959	15.0	16.5	1.5

Program Direction and Administration

Mr. Rabaut. Program direction and administration, $54.9 million. (The justification is as follows:)

Program Direction and Administration—Operating Costs

Program statement

Estimate, fiscal year 1961	$54,900,000
Estimate, fiscal year 1960	52,000,000
Increase	2,900,000

General direction of Commission programs is executed by Commission employees budgeted under "Program direction and administration." These employees are responsible for (1) arranging for the work to be accomplished, and negotiating and administering production, research and development, construction, and related contracts; (2) maintaining necessary liaison with contractors to assure protection of the Government's interests in contract performance; (3) developing standards and control measures for internal security and protection of Government funds and property; (4) encouraging private civilian applications of atomic energy, granting licenses for peaceful uses of atomic energy, and conducting compliance inspections of licensees; (5) conducting a program of cooperation with other nations, regional groups such as the European Atomic Energy Community, and the International Atomic Energy Agency; and (6) providing normal administrative and management services required within the Agency.

Program direction and administration activities are conducted through the headquarters and 12 operations offices and their subordinate area and branch offices.

The costs of program direction and administration include the costs of personal services, travel, supporting costs for office operation and maintenance, certain activities conducted directly by the Commission, contribution to civil service retirement fund, cost of administrative equipment, and for the first time, costs of the Federal Employees Health Benefits Act. The estimates are based on progressive recruitment in fiscal year 1961 to reach by June 30, 1961, a strength of 4,970 full-time permanent employees, which represents an increase of 100 over the estimated strength of 4,870 employees on June 30, 1960.

Summary of estimates by category

Category	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
1. Personal services	$37,509,273	$38,827,000	$40,085,000
2. Travel	2,075,578	2,400,000	2,650,000
3. Other objects	9,362,557	10,101,000	11,070,000
4. Equipment not included in construction projects	464,757	672,000	1,095,000
Total, program direction and administration	49,412,165	52,000,000	54,900,000

JUSTIFICATION OF CATEGORIES

1. Personal services, $40,085,000

This budget provides for an average employment in fiscal year 1961 of 4,920 permanent full-time employees, plus a small number of professional and scientific consultants whose services are utilized intermittently for limited periods, and a small number of employees in temporary positions to meet special situations. A breakdown of total personal services costs under this program follows:

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(*a*) Net cost of permanent full-time employees, including terminal leave costs	$36,568,512	$37,781,000	$39,096,000
(*b*) Costs of other employees	386,746	296,000	339,000
(*c*) Regular pay in excess of 52-week base	145,741	287,000	150,000
(*d*) Payment above basic rates	373,274	428,000	450,000
(*e*) Reimbursement to other agencies	35,000	35,000	50,000
Total, personal services	37,509,273	38,827,000	40,085,000

(*a*) Net cost of permanent full-time employees, including terminal leave costs:

Fiscal year 1959	$36,568,512
Fiscal year 1960	37,781,000
Fiscal year 1961	39,096,000

The estimates provide for employment at the beginning and end of the fiscal year as follows:

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
Starting employment	4,829	4,746	4,870
Ending employment	4,746	4,870	4,970

Computation of the dollar estimates:

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
(1) Average employment	4,738	4,810	4,920
(2) Plus man-year equivalent for terminal leave costs	28	28	28
(3) Total permanent man-years	4,766	4,838	4,948
(4) Average man-year cost	$7,673	$7,809	$7,901
(5) Net cost of permanent full-time employees, including terminal leave costs (line 3 multiplied by line 4)	$36,568,512	$37,781,000	$39,096,000

The man-year equivalent for terminal leave payments covering estimated separations from Government employment is based on current experience.

The average permanent full-time man-year cost reflects an increase of $92 in fiscal year 1961. This increase results primarily from estimated automatic in-grade advancements.

JUSTIFICATION FOR INCREASE OF PERMANENT FULL-TIME EMPLOYEES

The estimates for personal services under this program would provide for an increase of 100 permanent full-time employees in fiscal year 1961 over the estimated strength of 4,870 on June 30, 1960, to reach a total of 4,970 by June 30, 1961. The need for additional staff stems chiefly from greater workloads associated with research and development programs which continue to reflect increases in dollar volume, number of contracts, diversification, and complexity.

It is and has been the policy of the Commission to operate with the minimum level of staff for program direction and administration consistent with responsibilities and changing programs and workloads. Although in the past few years large increases have been experienced in workload and in the level of operating costs, the level of staffing for program direction and administration functions reflects only relatively minor increases. For example, over a period of 6 years ending June 30, 1961, it is estimated that total operating costs will show an increase of 74 percent, costs of major research and development programs (reactor development, physical research, and biology and medicine) will show an increase of 161 percent, while the level of staffing for program direction and administration will show an increase of only about 14 percent.

The proposed utilization of the 100 positions requested in fiscal year 1961 is as follows:

(*a*) *Reactor development, +84*

During fiscal year 1960, the administration of most of the projects included in the reactor development program has been assigned to the field offices. This has been done to permit a more adequate review of contractor effort closer to the site of actual operations. Previously, contract administration was performed largely within the headquarters. With the increasing scope and magnitude of this program, it has become necessary to redistribute the workload among the field offices and provide additional staff. Operations offices in Chicago, New York, Idaho, and San Francisco have been assigned the administration of virtually all new projects being initiated in both fiscal years 1960 and 1961. Within the headquarters, considerable effort will be directed toward increased planning, coordination, and reporting to enable top management to effectively administer the AEC effort.

(*b*) *Plowshare, +5*

During fiscal year 1961 there will be an increase in the diversity of field activities relating to application of nuclear explosives for peaceful uses. This will require additional program direction and liaison duties for the San Francisco operations office which has been assigned responsibility for the administration of this project. Present activity of San Francisco includes the evaluation of feasibility studies, negotiating contracts for area surveys and site preparation, and liaison with laboratories and industrial firms with a view toward the possible application of nuclear explosives to particular problems. As studies and surveys are completed and move to succeeding stages, field experiments will increase requiring additional staff to provide program direction for these experiments.

(*c*) *Licensing and regulation, +5*

This area of AEC effort has continued to increase since its inauguration by the Atomic Energy Act of 1954. Applications for licenses of all kinds are being received in greater numbers each year. As part of the review and processing of license applications, the AEC must insure that adequate measures are taken to protect the health and safety of the public including all individuals concerned with the operation of nuclear reactors and utilization of source, special nuclear and byproduct materials. Additional personnel in this area are required for more expeditious handling of the work as well as to meet increasing requirements. A further impact in this area will come from the need for providing orientation through on-the-job training to State employees in implementation of Public Law 86–373.

(*d*) *Other programs, +6*

Six additional positions are required to meet increasing requirements of the Headquarters Divisions of Inspection, Intelligence and Research, and the Office of Health and Safety.

The following table reflects by office the actual strength of permanent full-time employees as of June 30, 1959, and the currently planned distribution at June 30, 1960, and June 30, 1961:

Office	Actual strength, June 30, 1959	Estimated strength, June 30, 1960	Estimated strength, June 30, 1961
Grand Junction	114	112	108
Hanford	246	261	261
Oak Ridge	647	655	655
Savannah River	219	214	214
Albuquerque	780	780	780
San Francisco	165	180	196
Chicago	278	296	321
Idaho	158	175	188
Lockland	70	87	87
New York	213	228	248
Pittsburgh	92	96	96
Schenectady	90	90	90
Headquarters and extensions	1,674	1,696	1,726
Total	4,746	4,870	4,970

(*b*) Costs of other employees:

Fiscal year 1959	$386,746
Fiscal year 1960	296,000
Fiscal year 1961	339,000

These costs cover salaries of temporary, part-time, and intermittent employees. The bulk of these costs in fiscal year 1961 is for salaries of personnel who are paid only when employed, such as members of the General Advisory Committee, the Patent Compensation Board, the Advisory Committee for Reactor Safeguards, other boards, committees, panels, consultants, and experts.

(*c*) Regular pay in excess of 52-week base:

Fiscal year 1959	$145,741
Fiscal year 1960	287,000
Fiscal year 1961	150,000

These costs cover salaries of permanent employees for days of pay in excess of 260 days of pay in 1 fiscal year. One extra day is involved in fiscal year 1961.

(*d*) Payment above basic rates:

Fiscal year 1959	$373,274
Fiscal year 1960	428,000
Fiscal year 1961	450,000

These costs cover payments for scheduled and emergency overtime, night-work differential, living and quarters allowances, and other authorized special allowances for AEC employees stationed overseas. The increased costs in fiscal year 1961 are related primarily to living and quarters and special oversea allowances.

(*e*) Reimbursement to other agencies:

Fiscal year 1959	$35,000
Fiscal year 1960	35,000
Fiscal year 1961	50,000

These costs in fiscal year 1961 cover reimbursement to the Department of State for furnishing secretarial service at the Johannesburg, South Africa office, and reimbursement to other agencies for services performed.

2. Travel, $2,650,000

This estimate covers the cost of domestic and foreign travel chargeable to program direction and administration. The travel costs under this program include the travel of three principal classes of personnel: (1) AEC permanent full-time employees; (2) AEC intermittent employees such as members of advisory groups and individual consultants; and (3) approximately 280 military personnel on duty with the AEC, whose salaries are paid by the Department of Defense, but whose duties require considerable travel on AEC business.

The amount requested is based on estimated requirements to discharge effectively overall Commission responsibilities, and includes travel essential for:

(1) A satisfactory degree of technical and administrative supervision over field offices and projects and liaison with contractors;

(2) Carrying out added responsibilities resulting from passage of the Atomic Energy Act of 1954, as amended, such as regulatory activities under the civilian application program, inspection of licensed facilities, and cooperation with States and local governments and private industry in many forms;

(3) Administering effectively the program of cooperation with other nations;

(4) Liaison with the International Atomic Energy Agency and regional groups such as EURATOM;

(5) Attendance of technical and scientific personnel at important domestic and foreign conferences and symposia;

(6) Coordination of and participation in oversea nuclear energy exhibits:

(7) Implementation of safeguards and control provisions of bilateral agreements for cooperation; and

(8) Necessary travel of advisory committees, boards, and consultants.

The fiscal year 1961 estimates provide for a higher level of travel to meet increasing requirements of the Commission in practically all areas mentioned above. The increase over fiscal year 1960 for travel is attributable primarily to the following:

(1) Expanded research and development programs, requiring more travel to provide a satisfactory degree of technical and administrative supervision and review.

(2) Expansion of domestic license inspection program and international safeguards program;

(3) Travel of foreign office personnel including assignments and replacements;

(4) Travel to first duty station for employees in short supply categories pursuant to Public Law 85–479; and

(5) Travel associated with the new production reactor under construction at Hanford.

3. Other objects, $11,070,000

This estimate covers all costs of operations at the headquarters and in the field chargeable to program direction and administration except personal services, travel, and equipment. The chief items included are transportation of things, communications, rents, utilities, printing and reproduction, various contractual services rendered by civilian contractors and other Government agencies, maintenance and operation of buildings and grounds, supplies and materials, contributions to the civil service retirement fund, and for the first time, the costs of the Federal Employees Health Benefits Act of 1959.

The breakdown of other objects requirements between field offices and the headquarters is—

Field offices	$5,682,000
Headquarters and extensions	5,388,000
Total	11,070,000

Field offices.—The fiscal year 1961 estimate for field offices, except for contributions to the civil service retirement fund and for the Federal Employees Health Benefits Act of 1959 is based on past experience of requirements for effective, yet economical operations, and is related directly to the estimated average employment. Additional costs will be incurred in fiscal year 1961 over past experience for specific items, such as rental of space and leased communications land lines for relocation of the Albuquerque Emergency Relocation Center and for increased costs covering contractor services provided by the General Electric Co. for the Lockland Operations Office.

A breakdown of costs in field offices by activity for the 3 years follows:

Activity	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
Transportation of things: Includes transportation of Government property and employees' household goods	$77,130	$109,000	$109,000
Communications services: Includes costs of telephone service including equipment and circuit rental, and teletype service	874,586	947,000	997,000
Rents and utilities: Includes costs of rental of office and other administrative space and utilities	604,947	691,500	766,000
Printing and reproduction: Includes charges for printing, binding, photostating, and reproduction services	126,449	148,000	148,000
Other contractual services: Covers costs of maintenance and operation of administrative buildings and equipment, Federal employees life insurance fund, Federal Employees Health Benefits Act of 1959, guard services, and various services performed by other agencies and private contractors	1,141,502	1,296,500	1,676,500
Supplies and materials: Includes costs of general office supplies, technical and professional books, and gasoline, oil, and parts for Commission-owned vehicles	337,432	364,000	370,500
Grants, subsidies, and contributions: Covers costs of civil service retirement contributions	1,492,123	1,534,000	1,591,000
Refunds, awards, and indemnities: Covers costs of employee awards given under the incentive awards program and payments under the Tort Claims Act	11,436	21,000	21,000
Taxes and assessments: Includes costs of contributions under Federal Insurance Contributions Act	2,319	3,000	3,000
Total, field offices	4,667,924	5,114,000	5,682,000

Headquarters and extensions.—This estimate includes costs required at the Germantown headquarters and for maintenance of a small office on a permanent basis in the District of Columbia. The estimates have been developed by detailed analysis of needs under the various activities to provide the level of services and materials required for economical and efficient operations. Increases in fiscal year 1961 are provided for a higher level of employment, additional costs for foreign offices, full year's costs of the first increment of the emergency communications system initiated in fiscal year 1960, and essential requirements under various specific items.

A breakdown of costs in the headquarters by activity for the 3 years follows:

Activity	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
Transportation of things: Includes costs for shipments of supplies and materials, transportation of Government property, and shipment of household goods of employees in connection with domestic and foreign transfers	$85,438	$96,000	$106,000
Communications services: Covers costs of telephone service, including equipment and circuit rental and installation costs, long-distance toll calls and tieline services, teletype service; and payments to the Post Office Department in lieu of postage	1,043,520	1,173,000	1,295,000
Rents and utilities: Includes costs of electric power, water, and sewage charges at Germantown, and rental of specialized equipment	134,135	157,000	163,000
Printing and reproduction: Includes costs of printing forms, letterheads, routine reports, etc.; special printing and duplicating services performed by other agencies; and contractual duplicating services for press releases and informational materials	291,322	296,000	300,000
Other contractual services: Includes operation and maintenance of buildings and grounds, guard services, and motor transportation services provided by General Services Administration; administrative support furnished by Department of State for foreign offices; other miscellaneous services performed by other agencies; services contracted for, such as repairs and maintenance of equipment, transportation, reporting services for conferences and hearings, and official entertainment both at headquarters and field offices; costs of the Federal Employees Health Benefits Act of 1959 and employees life insurance fund	1,887,934	2,046,000	2,254,000
Supplies and materials: Includes costs of office and other supplies; technical and professional books; gasoline, oil, and parts for Commission-owned vehicles; and Commission-wide subscriptions for newspapers and periodicals	293,811	298,000	308,000
Grants, subsidies, and contributions: Includes costs of contributions to the civil service retirement fund and, in fiscal year 1959 only, commuting transportation for employees	949,002	903,000	944,000
Refunds, awards and indemnities: Includes costs of employee incentive awards program	7,188	15,000	15,000
Taxes and assessments: Includes costs of contributions under Federal Insurance Contributions Act	2,283	3,000	3,000
Total, headquarters and extensions	4,614,633	4,987,000	5,388,000

4. Equipment not included in construction projects, $1,095,000

This category covers replacement and additional administrative equipment such as office machines and furniture, motor vehicles and operating equipment required at the headquarters and field offices. The requirement in fiscal year 1961 breaks down into four major parts which are justified below:

(*a*) Additional office furniture and machines for staff increases	$40,000
(*b*) Additional miscellaneous equipment not related to staff increases	330,000
(*c*) Terminal radio and cryptographic equipment	500,000
(*d*) Replacement equipment	225,000
Total	1,095,000

(*a*) *Additional office furniture and machines for staff increases.*—The budget provides for an increase in staff of 100 employees in fiscal year 1961 over the estimated strength at June 30, 1960. It is estimated that additional office furniture and machines will be required for 80 of these employees.

(*b*) *Additional miscellaneous equipment not related to staff increases.*—This requirement covers miscellaneous equipment such as special files, library equipment, reproduction equipment, miscellaneous office equipment in all offices and various types of equipment required in the warehouse and for grounds maintenance at the headquarters. The fiscal year 1961 estimate also includes $285,000 for purchase of radioteletype and ancillary equipment for the relocation of the Albuquerque operations office emergency relocation center and for the purchase of a mobile trailer with equipment for a supplementary emergency relocation center for the San Francisco operations office.

(*c*) *Terminal radio and cryptographic equipment.*—Emergency exercises have demonstrated inadequacies in the AEC's emergency communications capability. As an immediate measure to improve the capability, it is planned to procure additional radio and cryptographic equipment. In fiscal year 1960, procurement is underway of long- and medium-range radio units to provide minimum transmitting facilities should land lines linking our principal emergency relocation centers become inoperative, and of portable cryptographic units to provide cryptoteletype capability under many conditions prevalent during emergencies. The fiscal year 1961 estimate provides for expansion of the system of radio and cryptoteletype to other AEC installations and for the addition of voice encrypting and facsimile encrypting equipment.

(*d*) *Replacement equipment.*—This requirement is for the replacement of equipment meeting prescribed replacement criteria and other equipment which is unserviceable or on which further repairs are uneconomical.

The breakdown of the fiscal year 1961 estimate between the headquarters and field offices is:

Headquarters	$620,000
Field offices	475,000
Total	1,095,000

PERSONNEL REQUIREMENTS

Mr. RABAUT. A rough calculation indicates that the average salary of the 100 additional employees you plan to hire will be at least $11,500. Please give us for the record a tabulation of the positions by grade and title that you expect to fill. Also indicate your present average salary rate.

There follows a tabulation of the 100 additional employees by grade and title, which are expected to be hired in fiscal year 1961. The average salary of these employees is $8,050:

Title	Grade	Number	Title	Grade	Number
Branch Chief, Reactor Branch	GS-15	1	Liaison officer	GS-13	2
Chief, East-West scientific exchange program	GS-15	1	Industrial hygienist	GS-13	1
Branch Chief, Reactor Branch	GS-14	1	Reactor engineer	GS-12	2
Assistant Director, technical services	GS-14	2	Resident engineer	GS-12	2
Reactor engineer	GS-14	2	Construction engineer	GS-12	1
Project representative	GS-14	2	Nuclear engineer	GS-12	3
Health physicist	GS-14	2	Mechanical engineer	GS-12	2
Metallurgist	GS-13	1	General engineer	GS-12	2
Sanitary engineer	GS-13	1	Project engineer	GS-12	1
Reactor engineer	GS-13	16	Accountant	GS-12	1
Chemical engineer	GS-13	2	Administrative officer	GS-12	1
Electrical engineer	GS-13	1	Reactor engineer	GS-11	6
Nuclear engineer	GS-13	2	General engineer	GS-11	1
General engineer	GS-13	1	Reports officer	GS-11	1
Project engineer	GS-13	3	Contract administrator	GS-11	2
Physicist	GS-13	3	Junior engineer	GS-9	2
Inspection specialist	GS-13	4	Clerk-stenographer	GS-5	2
Physical science administrator	GS-13	1	Secretary	GS-5	5
Licensing analyst	GS-13	1	Reports clerk	GS-5	1
			Clerk-stenographer	GS-4	14
			Clerk-typist	GS-3	1
			Total		100

The average salary of permanent full-time employees in program direction and administration is estimated at $7,809 in fiscal year 1960 and $7,901 in fiscal year 1961.

Mr. RABAUT. Please furnish a comparison of your costs and estimates for the past 5 years.

(The material referred to follows:)

Program direction and administration program—Comparison of congressional submission with actual cost experience

[In millions of dollars]

	Amount	Actual	Difference
Fiscal year 1955	$33.0	$33.0	0
Fiscal year 1956	35.8	35.3	−$0.5
Fiscal year 1957	39.4	38.0	−1.4
Fiscal year 1958	44.4	45.9	1.5
Fiscal year 1959	46.6	49.4	2.8

OTHER OBJECTS

Mr. RABAUT. Concerning your other objects, the tabulations on page 226 indicate that it costs you almost as much to run the headquarters office with 1,700 employees as it does all the field offices put together with 3,230 employees. Why?

Mr. MCCARTHY. The "Other objects" is one of the large items, Mr. Chairman. Of course in here we do have some of the tieline expense, communication expense of course that are not comparable in the field. There are a number of items paid for out of headquarters office here which total up and add to the "Other objects" expense for the headquarters office.

Mr. RABAUT. Please expand on that for the record. It is not quite understandable to me, so put the answer in the record.

Mr. MCCARTHY. I will, sir.

(The material referred to follows:)

The headquarters "Other objects" estimate of $5.4 million includes costs of $1.3 million for many services for the entire AEC, such as postage, tielines, teletype interconnections, AEC forms and letterheads, miscellaneous printing and reproduction, cryptographic and other supplies, official entertainment, newspapers and periodicals, patent filing fees, costs for foreign offices, etc.

Also included are costs of $1.4 million for maintenance and operation of the headquarters building at Germantown. This type of cost is at a significantly lower rate in the field since certain operations offices occupy space furnished by the General Services Administration without cost.

Mr. RABAUT. Your telephone service and postage is costing you a total of $11,460 a day based on a 200-day year. This is a sizable increase, totaling $172,000 over fiscal 1960. What positive controls are in effect to keep costs like these within reason?

Mr. MCCARTHY. We have a continual check to try to keep our telephone calls down, especially our long distance calls. The big item of increase in 1961 over 1960 is the rerouting of some of our tielines from the Washington headquarters to the field. This is mainly to get them out of the target areas so that we will have a communications system in the event of emergency.

Mr. RABAUT. No one is complaining about emergency use, but you know there is tremendous abuse in the Government of the use of the telephone. This is a big bill here.

(The following additional material was furnished the committee:)

Long distance telephone calls are controlled at the headquarters by means of a quota system which limits the number and average length of calls which can be made by each headquarters division and office. The quotas are established quarterly. Monthly billings are referred to the various divisions and offices for certification as to necessity for making such calls in the interest of the Government. In addition, monthly tabulations are prepared for circulation to management showing comparative costs and decreases or increases by organizational units. Internal control of the established quotas is the responsibility of the individual heads of divisions and offices.

Mr. RABAUT. The Commission's various development projects are conducted under contract by private industry. What type of contracts are they? How much is allowed these contractors for overhead expenses? How often are these contract costs audited? Will you supply the answers to the three questions for the record?

(The information referred to follows:)

CONTRACT ADMINISTRATION

1. *Type of contract.*—Typically the Commission's development projects are under cost-type contracts. This means that the Commission reimburses the contractor for costs where nonprofit organizations are concerned and, as a rule, for cost-plus-fixed-fee where private industry is concerned. In the power development program, there is frequently a sharing of costs up to a ceiling.

2. *Overhead expenses.*—In connection with contracts with industrial concerns for the operation of AEC-owned facilities, general administrative expense is compensated through fee. Where such facilities are operated by universities, without fee, overhead expenses may be compensated in the form of a negotiated fixed amount. Where work is performed in contractor-owned facilities, overhead properly allocable to the contract work is allowed on the basis of AEC cost reimbursement principles. The amounts of such overhead payments vary with different contracts; contractors differ in their identification of costs as direct costs or indirect costs; and volume of work, organization, and other factors also influence the amount of overhead charges.

3. *Audit.*—AEC contract costs are audited currently but not less frequently than once a year.

SECURITY INVESTIGATIONS

Mr. RABAUT. Security investigation, $6,097,000.

Please insert pages 272 through 275 of the justification.

(The justification is as follows:)

SECURITY INVESTIGATIONS PROGRAM—OPERATING COSTS

Program statement

Estimate, fiscal year 1961	$5,862,000
Estimate, fiscal year 1960	6,097,000
Decrease	235,000

This program includes cost of security investigations of individuals for whom clearance is required by the Atomic Energy Act of 1954, as amended. Cost of investigations of individuals for whom security clearance is required under the access permit program is excluded. This is budgeted under "Other costs."

The Atomic Energy Act of 1954, as amended, provides that no individual shall be permitted access to restricted data until the U.S. Civil Service Commission, or, under certain conditions, the Federal Bureau of Investigation shall have made an investigation and report to AEC on the character, associations, and loyalty of the person concerned and the AEC shall have determined that permiting such an individual access to restricted data will not endanger the common defense and security. Published policies and procedures provide guidance in determining need for AEC security clearance.

Pursuant to provisions of section 145(e) of the Atomic Energy Act, as amended, distribution of total investigative caseload between the Civil Service Commission

and the Federal Bureau of Investigation is based on Commission-approved criteria. Requests for investigation for individuals who are to occupy positions of a high degree of importance or sensitivity are referred to the Federal Bureau of Investigation; all others to the Civil Service Commission.

The Commission-approved program for selective reinvestigation of previously cleared personnel continues in order to assure that the program is protected from individuals whose clearance eligibility may have changed since time of last clearance action in their cases.

Clearance needs of AEC contractors account for about 75 percent of the 16,125 Q-type investigations budgeted for fiscal year 1961. Clearance of AEC personnel represent 7 percent of the total requirement; reinvestigations of persons previously cleared, 6 percent; and clearance of others, including suppliers and employees of other Government agencies, amount to 12 percent.

The following table shows the estimated number of new cases to be referred to the investigating agencies, the number of cases in process at the end of the year, and the estimated number of cases completed for both full background investigations (Q clearance) and national agency checks (L clearance). Costs are expressed in the number of completed uints of investigation multiplied by the unit cost per investigation. Unit costs are those furnished by the investigating agencies.

Summary of estimates

Item	Actual, fiscal year 1959		Estimated, fiscal year 1960		Estimated, fiscal year 1961	
	Q	L	Q	L	Q	L
1. Number of new cases referred to investigating agency:						
Federal Bureau of Investigation	4,700		3,700		3,500	
Civil Service Commission	15,002	6,763	13,350	6,000	12,625	5,500
Total	20,702	6,763	17,050	6,000	16,125	5,500
2. Number of cases in process at end of year in investigating agency:						
Federal Bureau of Investigation	204		200		200	
Civil Service Commission	2,204	177	2,000	160	1,900	150
Total	2,408	177	2,200	160	2,100	150
3. Cases completed during year:						
Federal Bureau of Investigation	5,082		3,704		3,500	
Civil Service Commission	16,057	6,837	13,554	6,017	12,725	5,510
Total	21,139	6,837	17,258	6,017	16,225	5,510
4. Cost of completed investigations:						
Q clearances:						
Number completed by Federal Bureau of Investigation	5,082		3,704		3,500	
Cost per investigation	[1] $285.00		$285		$285	
Total cost, FBI	$1,459,200.00		$1,055,640		$997,500	
Number completed by Civil Service Commission	16,057		13,554		12,725	
Cost per investigation	[1] $339.22		$370		$380	
Total cost, CSC	$5,446,850.00		$5,014,980		$4,835,500	
Total Q clearances	$6,906,050.00		$6,070,620		$5,833,000	
L clearances:						
Number completed by Civil Service Commission	6,837		6,017		5,510	
Cost per investigation	[1] $6.57		$7		$7	
Total L clearances, CSC	$44,919.00		$42,119		$38,570	
Total cost of completed cases	$6,950,969.00		$6,112,739		$5,871,570	
5. Adjustment for partially completed cases at end of year	+$44,207.00		−$15,739		−$9,570	
6. Total security investigations program	$6,995,176.00		$6,097,000		$5,862,000	

[1] Average cost.

JUSTIFICATION OF ESTIMATES

The estimated number of cases to be referred for full field investigation (item 1 of the preceding table) is summarized below:

Full field investigations (Q clearance)

Category	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
AEC	1,043	1,196	1,097
Contractor:			
Construction	1,248	533	421
Operating	15,266	12,455	11,767
All others	1,892	1,966	1,940
Reinvestigations	1,253	900	900
Total	20,702	17,050	16,125

Mr. RABAUT. Last year you estimated your 1960 security investigation cost at $7,390,000. Now you say that they will be only $6,097,000 or $1,293,000 less. May we assume that you have also substantially overestimated your 1961 costs?

Mr. MCCARTHY. No, sir. I don't believe we can assume this. We have tried to take the best evaluation of the number of cases to be processed in 1961. There were less cases processed in 1960 than were originally estimated. In the meantime the cost per case has gone up. The civil service cost has gone up somewhat over what we had estimated in 1960, and it now appears that the FBI cost may even be higher in 1961.

Mr. RABAUT. Now we have here on page 272, the 1961 request for $5,862,000. Why don't you settle that for $5.5 million and give me a little encouragement here for an afternoon's work?

Mr. MCCARTHY. It could well be that you are more correct than we are.

Mr. RABAUT. Please put in the record a tabulation showing estimates and costs for this item for the last 5 years.

Mr. MCCARTHY. We will, sir.

(The information referred to follows:)

Security investigation program—Comparison of congressional submission with actual cost experience

[In millions of dollars]

	Amount available	Actual	Difference
Fiscal year 1955	$9.6	$9.8	$0.2
Fiscal year 1956	5.7	7.5	1.8
Fiscal year 1957	6.6	8.4	1.8
Fiscal year 1958	8.4	7.6	−.8
Fiscal year 1959	6.2	7.0	.8

OTHER COSTS AND SELECTED RESOURCES

Mr. RABAUT. Other costs, $6,500,000. Insert pages 276 through 279. Selected resources, $28,434,000. Insert pages 280 through 290.

(The justification is as follows:)

OTHER COSTS

Program statement

Estimate, fiscal year 1961	$6,500,000
Estimate, fiscal year 1960	5,800,000
Increase	700,000

Under the program "Other costs," the Commission budgets for certain costs incurred in the manufacture of materials, which it sells to eligible purchasers, and in rendering laboratory, research, and other services to industrial and research organizations. Reimbursements received by the Commission for products and services furnished are applied to reduce the Commission's fund requirements. They constitute an offset against other costs and are shown under the program "Revenues applied." The increase in estimated costs is related primarily to an increased level of sales of radioisotopes and increased use of irradiation services. The increase is partially offset by a decreased level of sales of heavy water and a decreased level of security investigations for access permitholders.

Summary of estimates by category

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
1. Other costs:			
(*a*) Costs of products sold	$4,271,026	$4,515,000	$5,162,000
(1) Cost of special reactor materials sold	1,764,068	1,430,000	1,152,000
(2) Cost of isotopes sold	2,497,469	3,007,000	3,960,000
(3) Cost of processing and handling of source and nuclear materials sold	9,489	78,000	50,000
(*b*) Costs of services	1,288,646	1,285,000	1,338,000
(1) Special studies	107,459	124,000	124,000
(2) Use of AEC facilities and equipment	145,346	115,000	115,000
(3) Irradiation services	170,957	285,000	385,000
(4) Special processing, fabrication and separation and recovery of materials	111,045	237,000	237,000
(5) Security investigations	637,645	376,000	262,000
(6) Other services	116,194	148,000	215,000
Total, other costs	5,559,672	5,800,000	6,500,000
2. Related revenue included under program "Revenues applied"	7,750,870	8,160,000	8,600,000
3. Excess of revenue over costs	2,191,198	2,360,000	2,100,000

JUSTIFICATION OF CATEGORIES

1 a. (1) Cost of special reactor materials sold, $1,152,000

Includes cost of heavy water sales, principally to foreign countries and cost of boron 10 to domestic users. Decrease of $278,000 in fiscal year 1961 from the fiscal year 1960 estimate is due to a reduction in sales of heavy water. Related revenue in amount of $2,270,000 is included under the program "Revenues applied."

1 a. (2) Cost of isotopes sold, $3,960,000

Includes cost of isotopes sold to research laboratories, industry, and educational institutions. The increase of $953,000 from the fiscal year 1960 estimate is related to increased sales of isotopes in fiscal year 1961. Related revenue in amount of $4,650,000 is included under the program "Revenues applied."

1 a. (3) Cost of processing and handling of source and nuclear materials sold, $50,000

Includes cost of processing and handling of source and nuclear materials sold. Related revenue is included under the category "Income from special processing and fabrication" and separation and recovery under the program "Revenues applied."

1 b. (1) Cost of special studies, $124,000

Includes cost of special studies for non-AEC users. Related revenue in amount of $150,000 is included under the program "Revenues applied."

1 b. (2) Cost for use of AEC facilities and equipment, $115,000

Includes cost incurred in connection with the use of AEC facilities and technical equipment for non-AEC users and AEC contractors for their own private use for work in the field of atomic energy. Related revenue in amount of $145,000 is included under the program "Revenues applied."

1 b. (3) Cost of irradiation services, $385,000

Includes cost incurred for irradiation services performed in AEC-owned facilities for non-AEC users. Related revenue in amount of $465,000 is included under the program "Revenues applied."

1 b. (4) Cost of special processing, fabrication and separation and recovery of materials, $237,000

Includes cost incurred in connection with special processing, fabrication and separation and recovery of materials. Related revenue in amount of $330,000 is included under the program "Revenues applied."

1 b. (5) Cost of security investigations, $262,000

Includes cost incurred by AEC in connection with security investigations obtained for access permit holders. As a means of encouraging American industry to participate more fully in the Atomic Energy program, the Commission initiated a program for release of selected classified nonmilitary information, after obtaining the necessary security clearances, to applicants who can demonstrate the information is needed in their business or profession. It is estimated that 380 limited security clearances and 683 full field investigations will be completed during fiscal year 1961 at a total cost of $262,000, and the Commission will accrue approximately $300,000 in revenue from such security investigations. Estimated revenue is included under the program "Revenue applied."

1 b. (6) Cost of other services, $215,000

Includes cost of other services rendered by AEC and its contractors to outside organizations. Related revenue in amount of $290,000 is included under the program "Revenues applied."

2. Related revenue included under program "Revenues applied," $8,600,000

The estimated total revenue related to the sale of products and services included in the program "Other costs" is $8,600,000 as compared to the cost of the related products and services of $6,500,000, reflecting an excess of revenue over cost of $2,100,000 on the products and services included in this program.

INCREASE OR DECREASE IN SELECTED RESOURCES

Program statement

Estimate, fiscal year 1961	$964,387,215
Estimate, fiscal year 1960	935,953,215
Increase	28,434,000

This program "Increase or decrease in selected resources" presents the net increase or decrease in levels of resources required to support the programs of the Commission. This program includes requirements for inventories, collateral funds, and other deposits, and goods and services on order. The category "Goods and services on order" includes contracts for materials and services to be delivered after fiscal year 1961 and financing of contractors in accordance with Commission policy beyond the end of the fiscal year to insure continuity of operations. The contractor requirements included in the estimate provide for 3 months of forward financing. The levels of selected resources are assets that may be applied to program costs of future years' operations.

The estimate of $28,434,000 for fiscal year 1961 consists of a decrease of $3,491,000 in inventory levels and an increase of $31,925,000 in the level of goods and services on order.

The net decrease in inventories of $3,491,000 consists of—

1. A decrease in stores inventory of $1,124,000 related principally to reductions in operating inventories of special nuclear materials contractors.

2. A decrease in special reactor materials inventory of $4,311,000 resulting primarily from utilization for program requirements of inventories on hand.

3. A decrease in other special materials inventory of $624,000 primarily attributable to reduction in inventory levels of barrier items.

4. An increase of $2,568,000 in isotopes inventory to support higher levels of research and a higher level of inventory items for sale and lease to research and industrial users.

The increase in level of goods and services on order is related to program cost levels at the end of fiscal year 1961.

Summary of estimates by category

Balances at end of year	Actual, 1959	Estimate, 1960	Estimate, 1961	Increase or decrease (−)
1. Inventories:				
(a) Stores	$90,326,315	$87,563,000	$86,439,000	−$1,124,000
(b) Special reactor materials	77,446,591	72,308,000	67,997,000	−4,311,000
(c) Other special materials	17,397,577	16,890,000	16,266,000	−624,000
(d) Isotopes	6,620,292	9,037,000	11,605,000	2,568,000
Total inventories	191,790,775	185,798,000	182,307,000	−3,491,000
2. Collateral funds and other deposits	20,693,649	20,684,000	20,684,000	0
3. Goods and services on order	669,410,371	729,471,215	761,396,215	31,925,000
Total unapplied resources at end of year	881,894,795	935,953,215	964,387,215	28,434,000
Increase or decrease in selected resources	18,265,361	54,058,420	28,434,000	

JUSTIFICATION OF CATEGORIES

1. Inventories: Decrease, $3,491,000

(a) Stores inventory: Decrease, $1,124,000.—Stores inventories are supplies, materials, and parts normally used or consumed in the production of source and special nuclear materials; in the maintennace of production plants, buildings, and other facilities; or in the operation of laboratories and experimental projects, communities and administrative activities. Stores exclude source and special nuclear materials, weapons components, special reactor materials, and other special materials.

The decrease of $1.1 million in the total level of stores inventory for fiscal year 1961 is related principally to reductions in operating inventories of special nuclear materials contractors.

(b) Special reactor materials inventory: Decrease, $4,311,000.—This inventory consists of selected materials used in the construction and operation of reactors for production and research purposes.

The decrease is related principally to reductions as a result of utilization for program requirements of inventories on hand.

A classified schedule of the inventory levels of special reactor materials is presented on classified page r–291.

(c) Other special materials: Decrease, $624,000.—Other special materials inventory is made up of the following items, requiring special accounting controls: Radium, gold, silver, platinum, rhodium, palladium, iridium, osmium, gallium, and barrier items.

The decrease is primarily attributable to a reduction in the inventory level for barrier items.

(d) Isotopes: Increase, $2,568,000.—The increase in the inventory levels of isotopes is indicated below:

	Estimate fiscal year 1960	Estimate fiscal year 1961	Increase
Stable isotopes	$4,344,000	$6,312,000	$1,968,000
Radioisotopes	4,693,000	5,293,000	600,000
Total inventory	9,037,000	11,605,000	2,568,000

The increase of $2.0 million in the stable isotopes inventory is based on requirements to meet the specific needs of cross section measurement activities. The increase of $0.6 million in the radioisotopes inventory is related to increased levels for sales.

2. Collateral funds and other deposits: Increase

No change is planned in fiscal year 1961 for collateral funds and other deposits. The fiscal year 1961 year-end balance includes $18,680,000 for collateral funds consisting of insurance collateral funds, employee benefit and annuity funds; and $2,004,000 in other deposits required by vendors on containers and other deposits of a miscellaneous nature. The collateral funds were established under contracts originally entered into by the War Department, and were designed to provide for various extraordinary contingencies in the activities of cost-type contractors. For the most part, collateral funds are held by trustees and invested in U.S. Government Securities.

The following table indicates the balances of collateral funds and other deposits as of the end of fiscal years 1959, 1960, and 1961:

Collateral funds and other deposits	Year-end balances		
	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Collateral funds by office and contract:			
Hanford, Wash., General Electric Insurance Fund-Travelers Insurance Co	$10,500,000	$10,500,000	$10,500,000
Albuquerque, N. Mex. Los Alamos-University of California Employees Benefit Fund	1,000,000	1,000,000	1,000,000
San Francisco, Calif., Berkeley-University of California Employees Benefit Fund	480,000	480,000	480,000
Chicago, Ill., University of Chicago Employees Benefit Fund	500,000	500,000	500,000
New York, N.Y., Columbia University Employees Benefit Fund	200,000	200,000	200,000
Washington, D.C., University of California, Los Alamos and University of Chicago Insurance Fund—Royal & Globe Co	6,000,000	6,000,000	6,000,000
Total Collateral Funds	18,680,000	18,680,000	18,680,000
Other deposits	2,013,649	2,004,000	2,004,000
Total collateral funds and other deposits	20,693,649	20,684,000	20,684,000

3. Goods and services on order: Increase, $31,925,000

Estimates for fiscal year 1961 are based on Commission policy of 3 months forward financing for cost-reimbusement-type contractors and funding of commitment levels at the end of the contract period to insure continuity of operations. The funding requirements are related to the cost levels presented under program costs. The increase in the level of goods and services on order is related primarily to—

(*a*) higher operating levels of research and development for the expanding reactor development and weapons programs, and

(*b*) increases in balances related to procurement of Canadian uranium concentrates deferred until future years.

A summary table of requirements by category is included below.

[In thousands]

Category	Yearend balances			Increase or decrease (−) in fiscal year 1961
	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961	
Good and services on order:				
A. Major long-term reimbursement contracts, over $1,000,000 annual operating level:				
(1) Contractors with principal effort in production of source and special nuclear materials	$149,142	$151,748	$159,526	$7,778
(2) Contractors with principal effort in production of weapons and weapon components	108,944	100,388	102,563	2,175
(3) Contractors with principal effort in research and development	259,979	278,825	288,793	9,968
(4) Contractors with principal effort in supporting services	9,881	5,691	4,520	−1,171
Total	527,946	536,652	555,402	18,750
B. Major material procurement contracts	34,602	28,448	45,204	16,756
C. Research and development, other than those contracts included under item A(3)	45,425	73,611	76,710	3,099
D. Cooperative arrangements program, civilian power reactors	37,969	62,137	55,521	−6,616
E. Utilities	2,612	2,371	2,130	−241
F. All other	20,856	26,252	26,429	177
Grand total, goods and services on order	669,410	729,471	761,396	31,925

Explanation of the increases and decreases in the balances of goods and services on order follows:

A. Major long-term reimbursement contracts, over $1 million annual operating level: Increase, $18,750,000

The estimates provide forward financing of 3 months in addition to financing the level of outstanding commitments at the end of this period. Increases or decreases by category of contracts are listed below.

(1) Contractors with principal effort in production of source and special nuclear materials: Increase, $7,778,000.—Reflects higher production levels of nuclear and reactor materials, and higher levels of research and development work by production contractors for other programs.

(2) Contractors with principal effort in production of weapons and weapon components: Increase, $2,175,000.—This increase is related to production of weapons to meet military requirements.

(3) Contractors with principal effort in research and development: Increase, $9,968,000.—This increase is related principally to—

(a) Higher levels of research and development on the civilian power reactor program, and on the weapons and other military programs such as the natural circulation reactor and the satellite power sources.

(b) Increased level of effort on the physical research program.

(4) Contractors with principal effort in supporting services: Decrease, $1,171,000.—This decrease is related principally to reduced level of caretaker costs at the Eniwetok Proving Ground.

B. Major material procurement contracts: Increase, $16,756,000

The net increase of $16.8 million in fiscal year 1961 represents:

(1) An increase in these balances of $24.5 million for procurement of Canadian uranium concentrates, delivery of which will be deferred until future years;

(2) A reduction of $1 million, related to the amortization of Combined Development Agency assets, based on the amount of concentrates to be received from CDA in fiscal year 1961; and

(3) A reduction of $6.7 million in the contracts for procurement of other materials as a result of amortization of assets based on deliveries during fiscal year 1961.

C. Research and development—other than those contracts included under item A (3): Increase, $3,099,000

The net increase of $3.1 million is related principally to increases in research and development effort on nuclear technology in such areas as advanced reactor development, reactor physics, fuels and materials, and residue processing and controls. In the balances shown in this category for fiscal year 1960 there is included $13.6 million for a computer for the Lawrence Radiation Laboratory which is required for increases in the computational load as a result of the intensive weapons effort at that location. The computer is expected to be delivered in fiscal year 1962. This increase for the computer was offset by a reduction in a like amount for irradiation test space contracts determined to be in excess of the amount of the currently estimated need for such contracts.

D. Cooperative arrangements program—civilian power reactors: Decrease, $6,616,000

The following table reflects the level of uncosted balances at the end of the fiscal year under various contracts in the cooperative arrangements program for the advancement of civilian nuclear power:

[In thousands]

	Year-end balances			Increase (+) or decrease (−) in fiscal year 1961
	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961	
(1) Fiscal year 1958 cooperative power reactor demonstration program:				
Yankee Atomic Electric Co	$113	0	0	0
Consumers Public Power District	8,518	$8,518	$8,518	0
R. & D. on Fast Breeder Technology	2	2	1,511	$1,509
Elk River-Rural Coop. Power Association	2,105	2,005	1,880	−125
City of Piqua, Ohio	2,433	3,516	3,516	0
Northern States Power Co	6,291	3,981	3,481	−500
Carolinas-Virginia Nuclear Power Association, Inc	10,410	10,098	8,098	−2,000
East Central and Florida Westcoast Nuclear Group	8,097	9,335	7,335	−2,000
Unapplied R. & D. funds	0	982	982	0
Subtotal	37,969	38,437	35,321	−3,116
(2) Fiscal year 1960 cooperative power reactor demonstration program:				
Other reactor prototypes	0	3,900	2,900	−1,000
Intermediate organic reactor	0	6,900	4,900	−2,000
R. & D. assistance for unsolicited proposals	0	3,500	0	−3,500
Advanced high-temperature reactor (Philadelphia Electric)	0	9,400	4,900	−4,500
Subtotal	0	23,700	12,700	−11,000
(3) Fiscal year 1961 cooperative power reactor demonstration program: Additional unsolicited proposals	0	0	7,500	7,500
Grand total	37,969	62,137	55,521	−6,616

E. Utilities: Decrease, $241,000

This decrease represents a reduction in the cancellation liability under the contract with the East Tennessee Natural Gas Co. for the supply of gas at Oak Ridge, Tenn.

F. All other: Increase, $177,000

This increase represents the net change resulting from minor adjustments in the levels of AEC obligations for miscellaneous contracts at several offices.

RADIATION SPACE

Mr. RABAUT. How much are you carrying in this item for space and test reactors not yet built and what assurance do you have that you will use it in 1961?

Mr. MCCARTHY. In the 1960 budget we have presented to this committee I think $27.5 million for radiation space. The committee reduced this by some little over $10 million. We had, as I recall, $16.6 million available this year. We are retaining roughly $3 million on the possibility of negotiating a contract for space in which we would have to obligate this amount as part of the cancellation charges on that reactor. This is the only amount still applicable to the purchase of space for test reactors, Mr. Chairman, on the possibility of getting that obligated this year. At the moment we are attempting to negotiate a contract on that.

Mr. RABAUT. Are the possibilities looking bright?

General LUEDECKE. We expect to complete the negotiation and make the contract.

Mr. RABAUT. The General Electric Co. engineering test reactor at Vallecitos, Calif., is being used to only 25 percent of its capacity. It is claimed by the company that they must charge $65 per radiation unit for the use of space in the machine in order to repay the investment, to carry the annual cost of taxes, operation, et cetera. The AEC has been charging only $55 per unit for use of Government-owned test reactors. General Electric claims that this keeps the AEC contractors and private industry from using their facility. It has been reported that both General Electric and Westinghouse, who have financed and owned test reactors, are seriously concerned because funds were made available in 1959 and 1960 to subsidize construction of additional private test reactors by contracting and paying for space in them before they are built. I understand AEC has this problem of differential in payments for use of space currently under study.

Who will discuss this problem for the committee?

Dr. PITTMAN. The problem on the existing reactors, sir, of both GE and Westinghouse, has been the problem of trying to negotiate a contract in which the timing on the availability of the reactors and on the need for the space in the reactors is recognized. It takes quite a while to build a loop to put in a reactor. When we look at our requirements for test space, and we find that those requirements are greater than the requirement that can be met in both MTR or ETR—in other words, in our own test reactors—it does take time to biuld the facility to put into the GE and Westinghouse reactors.

Mr. RABAUT. What about this complaint of theirs?

Dr. PITTMAN. The charges that we make—and I would like to ask if I am correct in this—the MTR and ETR charges that we have made for sponsors of commercial irradiation is $55. The General Electric test reactor, for example, has offered space at $65, I believe is the figure. We are negotiating with them on the basis of that offer at this time. There is a differential. The ETR is a much larger reactor than the General Electric reactor. It therefore furnishes space at a cheaper price.

Mr. RABAUT. Is there a problem of keeping development work confidential?

Dr. PITTMAN. I don't know of any problem on that, sir.

If we have a contract to purchase space in a reactor to get neutrons, just to buy neutrons, there is no problem of company confidential information.

Mr. RABAUT. Isn't there a problem that manufacturers want to use these machines, but are reticent for secrecy reasons?

General LUEDECKE. This would apply to industry putting their radiation in other private reactors, and thereby giving up their proprietary information. I don't believe that we can substantiate that, sir. We have not found any evidence of that.

Mr. RABAUT. You don't know anything about it?

General LUEDECKE. We have found no evidence that this is the case.

Mr. RABAUT. All right.

Dr. PITTMAN. You see, sir, the irradiations that we are talking about in our program are all irradiations that are a part of the AEC's paid for developmental program. We own the information that is generated in all of these developmental programs that we are talking about.

Mr. RABAUT. They are your own programs?

Dr. PITTMAN. Yes, sir. Those are the programs we are talking about.

Mr. RABAUT. But your rate is different than the rate of the other two companies I mentioned.

Dr. PITTMAN. Yes, sir.

Mr. RABAUT. Now, your capacity is larger, too?

Dr. PITTMAN. Yes.

Mr. RABAUT. I understand that.

Dr. PITTMAN. We do not furnish any service to private concerns, when service is otherwise available as it now is in the two test reactors.

Mr. RABAUT. Why should we issue additional invitations for private test reactors with the $3 million you still have?

Dr. PITTMAN. The situation is this: About a year ago it was determined that the space we have in our own facilities was inadequate to meet our estimated demands in the future for irradiation space. At that time, we put out an invitation to industry to give us proposals for meeting those demands. This invitation was directed to companies who had reactors, as well as to those who might want to build them. By far the best proposal that we received was from a company who proposed to build a reactor and to furnish at a quite low cost the irradiation that we need.

USE OF INDUSTRY REACTORS

Mr. RABAUT. Isn't this an area where Uncle Sam should actually build and operate what is needed?

Dr. PITTMAN. Well, I think there could be considerable discussion, sir, and differences of opinion on whether the Government should build these test reactors that we need for our own program, or whether we should attempt to get the facilities built by outside people. If we look to the future of the atomic energy program as it grows and as it comes more and more into the normal industrial channels, we felt at the time these invitations were issued that there is a need in the private industrial effort for test reactors of this type. I believe that both GE and Westinghouse on their own behalf built their own reactors because

of a similar view. Therefore, we issued invitations for private proposals and got such proposals.

Mr. RABAUT. What will happen to you if you don't get the $3 million?

Dr. PITTMAN. If we did not have the money available, we cannot consummate the contract for this test reactor.

Mr. RABAUT. What will happen to you?

Dr. PITTMAN. Just looking at our requirements for the next few years, this would mean that we would have to keep the MTR and the ETR completely loaded, as a matter of fact, even more highly loaded than makes good developmental sense, and in addition we would have to purchase from GE and Westinghouse essentially their entire capacity.

Mr. RABAUT. Why would you not load up the GE and Westinghouse facilities?

Dr. PITTMAN. I say we would have to use their facility as well as ours.

Mr. RABAUT. They say theirs are not loaded.

Dr. PITTMAN. That is right, but their prices are considerably higher. It would be most costly to the Government.

Mr. RABAUT. It would be more costly?

Dr. PITTMAN. Yes, sir.

Mr. RABAUT. Their price is $10 more?

Dr. PITTMAN. It is substantially more than that.

Mr. RABAUT. Will you need all of the estimated amount for the Lawrence Radiation Laboratory computer in 1961?

General LUEDECKE. We believe that we will, Mr. Chairman, to make the obligation. We have done quite a bit of checking and this is a quoted price on it. We have not negotiated with them, but I don't think we have reason to believe that it will be substantially less.

Mr. RABAUT. Do you need all this money for that or could you probably save some money here?

Mr. FLOBERG. If we can get it cheaper, we will get it cheaper, Mr. Rabaut.

Mr. RABAUT. You have not negotiated a price yet?

General LUEDECKE. No, sir; not yet. This is an estimate but the estimate is based on querying them about what the price is.

Mr. RABAUT. Have you any other yardstick to go by for this?

General LUEDECKE. Only that they have built one such computer and built it on a developmental basis.

Mr. RABAUT. Is this the total cost for this one?

General STARBIRD. Sir, we have tried to check several yardsticks before setting that figure. The figure actually is one that was quoted to us and as you say, we have not negotiated one. A computer is just being completed for us. It was on a developmental contract in which we made payments during the development and got the computer at the end.

Mr. RABAUT. Off the record.

(Discussion off the record.)

General STARBIRD. We know what they are costing. We know that is half the cost.

Mr. RABAUT. How much of the $24.5 million that you are showing on page 288 for the Canadian concentrates will you need in 1961?

Mr. MCCARTHY. This goes back to the problem of deferment beyond 1961 of the ore that we will get from Canada. As part of the agreement on the ore concentrates we advanced to them the amount of $2.50 per pound of the amount deferred. In other words, that will be an advance payment to the Canadian Government against future delivery of the concentrates that we have deferred.

Mr. RABAUT. Why do you give them advanced payments?

Mr. MCCARTHY. This is part of the agreement. This is part of the financing of their whole mill system; since we are deferring the take of the concentrates, we will be advancing them $2.50 a pound for each pound deferred. This is the amount that we will expend in 1961 as shown here.

Mr. RABAUT. Has this been the custom in the past?

Dr. WILSON. This is the first time we have stretched it out.

Mr. FLOBERG. Instead of paying the whole price for the uranium, we are paying a small part of the price and not taking delivery on the uranium in question. So we are really getting a great benefit out of this.

Mr. RABAUT. You are only paying an installment?

Mr. FLOBERG. Yes, and only the installment that is attributable to the amortization of the capital cost of the Canadian plants which of course is a matter of fixed obligation in the case of the plants. They have mortgages, and so forth.

Mr. RABAUT. Where do you leave this stored material that you buy?

Mr. FLOBERG. This material is still in the ground.

Mr. RABAUT. You are going to leave it in the ground?

Mr. FLOBERG. That is part of the plan, to avoid taking delivery, postponing delivery on it. Maybe some of it is above ground in some of the Canadian mills, but in any event it is not being delivered to us.

Mr. RABAUT. In other words, you have an option on it.

Mr. FLOBERG. We have more than an option. We have a contractual right to have delivery on it, but it is inconvenient for us to accept delivery now.

Mr. RABAUT. When you get it you pay the balance.

Mr. FLOBERG. That is correct.

Mr. RABAUT. This is under our agreement that runs to 1966?

General LUEDECKE. These are under firm contracts that do run into 1966. This is part of the means of stretching them out.

Mr. RABAUT. Your last year's estimate for 1960 for selected resources was $960,944,384. Now you say it is only $935,953,215 for 1960. If you miss your guess by the same amount in 1961, you would not need the appropriation of the $28,434,000 requested. Is this true?

Mr. MCCARTHY. One of the reasons that this is effected of course, is by some of the underruns that took place after our 1960 budget had come to you, and because of some changes in inventory. So there are a number of factors in this.

Mr. RABAUT. Some changes in your inventory?

Mr. McCarthy. Inventory in our hands. This is a combination of contracts outstanding for which we have obligations, and inventories reported at the end of the year.

Mr. Rabaut. Do you have that broken down as to how much was inventory and how much was contracts?

Mr. McCarthy. It shows in the record, in the justification.

Mr. Rabaut. What about missing the guess in the future?

Mr. McCarthy. So far as we can tell right now, our 1961 estimate is still good, Mr. Chairman.

Mr. Rabaut. Give us the estimates and the actual figures for the last 5 years for the record.

Mr. McCarthy. We will be glad to.

(The information is as follows:)

"Other costs" program—Comparison of congressional submission with actual cost experience

[In millions]

	Amount available	Actual	Difference
Fiscal year 1955	(1)	(1)	(1)
Fiscal year 1956	(1)	(1)	(1)
Fiscal year 1957	$6.4	$6.6	$0.2
Fiscal year 1958	4.9	6.5	1.6
Fiscal year 1959	6.7	5.6	−1.1

[1] "Other costs" program was included for the first time in the fiscal year 1957 congressional submission.

Increase or decrease in selected resources program—Comparison of congressional submission with actual cost experience

[In millions]

	Amount available	Actual	Difference
Fiscal year 1955	−$134.2	−$232.0	$97.8
Fiscal year 1956	62.7	91.9	29.2
Fiscal year 1957	53.2	68.8	15.6
Fiscal year 1958	97.8	77.3	[1] −20.5
Fiscal year 1959	38.2	18.3	[2] −19.9

[1] Included in this net difference is an underrun of $40.1 million related to program slippages in the cooperative arrangements program (civilian power reactors). This amount was unobligated at the end of fiscal year 1958 and carried over into fiscal year 1959 as part of this program. Increases in the program, exclusive of the above, amounted to $19.6 million.

[2] Included in this net difference is an underrun of $27.5 million related to irradiation test space contracts. A considerably longer period of time than was anticipated has been required to review proposals and negotiate contracts. (This amount was reduced to $16.6 million by congressional action on the fiscal year 1960 budget). Contracts are still under negotiation and it now appears that fund requirements will be much less than previously planned. Appropriate reductions have already been made in the budget. Increases in the program, exclusive of the above, amounted to $7.6 million.

Revenues Applied

Mr. Rabaut. Revenues applied, $22,600,000. Insert pages 292 through 298.

Revenues Applied

Program statement

Estimate, fiscal year 1961	$22,600,000
Estimate, fiscal year 1960	26,850,000
Decrease	4,250,000

The program "Revenues Applied" includes the income from sales and lease of products and services to eligible purchasers and other revenue from community operations, tuition income, hospitals, and other miscellaneous sources, such as income from royalties and collateral funds. The program "Revenues Applied" is presented in two categories on the following schedule of summary of estimates by category. The first category, "Revenue from sale of products and services," consists of items for which the related costs are included under the program "Other Costs" and the second category, "Other revenue," consists of revenue items for which the costs are reflected under the related program costs, and miscellaneous income such as royalty income, and other items of a miscellaneous nature.

Commission policy provides for full cost recovery for products and services, with the exception of waiver of use charges for special nuclear materials and heavy water under the cooperative arrangements program as authorized by law, discounts on isotopes used for medical and agricultural research, and other minor exceptions approved by the Commission. Revenues received are applied in the budget to reduce the appropriation requirements of the Commission.

The major changes in the fiscal year 1961 estimate which result in a net decrease of $4.2 million from the fiscal year 1960 estimate are:

	Millions
1. Decrease of revenue from community operations as a result of the disposal of revenue-producing utilities, housing, and commercial property at Oak Ridge, Tenn., and Richland, Wash	$4.8
2. Decrease in estimated sales of source and nuclear materials	.6
3. Decrease in estimated sales of heavy water	.6
4. Increase in revenues from sales of isotopes	.9
5. Increases in lease income from source, special and nuclear materials	.4
6. Increases in income from sale of nuclear heat or steam	.5

Summary of estimates by category

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
1. Revenue from sale of products and services (related costs are included under program "Other costs"):			
(a) Income from products sold	$6,719,118	$6,568,000	$6,920,000
(1) Sale of special reactor materials	3,544,164	2,840,000	2,270,000
(2) Sale and lease of isotpoes	3,174,954	3,728,000	4,650,000
(b) Income from services	1,031,752	1,592,000	1,680,000
(1) Income from special studies	130,233	150,000	150,000
(2) Income from use of AEC-owned facilities and equipment	165,978	142,000	145,000
(3) Income from irradiation services	210,037	360,000	465,000
(4) Income from special processing and fabrication and separation and recovery	130,433	330,000	330,000
(5) Income from security investigations	273,872	430,000	300,000
(6) Income from other services	121,199	180,000	290,000
Total revenue from sale of products and services	7,750,870	8,160,000	8,600,000
2. Other revenue (related costs are included when applicable under program costs of current or prior years):			
(a) Sale of source and special nuclear material	1,351,404	1,600,000	1,032,000
(b) Lease of source, special reactor, and nuclear materials	1,058,374	2,000,000	2,350,000
(c) Income from charges for special nuclear material consumed	0	302,000	98,000
(d) Income from sale of steam	2,222,888	1,560,000	2,060,000
(e) Income from research hospitals	374,274	375,000	375,000
(f) Income from training, education, and information activities	286,484	334,000	370,000
(g) Income from community operations	13,188,623	10,501,000	5,697,000
(h) Income from collateral funds	387,797	618,000	618,000
(i) Other miscellaneous income	1,458,609	1,400,000	1,400,000
Total other revenue	20,328,453	18,690,000	14,000,000
Total revenues applied	28,079,323	26,850,000	22,600,000

JUSTIFICATION OF CATEGORIES

1. Revenue from sale of products and services, $8,600,000

The gross revenue from the sale of products and services in this category for fiscal year 1960 in the amount of $8,600,000 is applied as a reduction of the total appropriation requirement of the Commission; however, it is pertinent to point out that the related costs of these products and services amount to $6,500,000, which is included as an appropriation requirement under the budget program "Other costs." The net revenue after deduction of costs is $2,100,000.

1(a)(1) Sale of special reactor materials, $2,270,000

This estimate consists principally of revenue from the sale of heavy water to foreign countries for reactor use, also includes domestic sale of minor quantities for research, and sale of minor qualities of boron 10. The decrease in revenues of $570,000 from the fiscal year 1960 estimate is attributable to a reduction in heavy water sales to foreign countries. The related cost of the material is $1,152,000, which is included in the program "Other costs."

1(a)(2) Sale and lease of isotopes, $4,650,000

This estimate includes revenue from the sale and lease of stable and radioisotopes to research laboratories, industry, and educational institutions. The increase of $922,000 from the fiscal year 1960 estimate is based on increased sales of isotopes in fiscal year 1961. The related cost of the products is $3,960,000, which is included in the program "Other costs."

1(b)(1) Income from special studies, $150,000

This estimate includes income derived from special studies for non-AEC users. Costs of services included under the program "Other costs" is estimated to be $124,000.

1(b)(2) Income from use of AEC-owned facilities and equipment, $145,000

This estimates includes income derived principally from use of Commission laboratory facilities for research work. Cost of services included under the program "Other costs" is estimated to be $115,000.

1(b)(3) Income from irradiation services, $465,000

This revenue is derived principally from irradiation services for research and industrial application performed at the National Reactor Testing Station. The increase of $105,000 from the fiscal year 1960 estimate is based on past experience which has indicated a steady growth in the number of experiments conducted since the startup of the testing station. Related cost of services included under the program "Other costs" is estimated to be $385,000.

1(b)(4) Income from special processing and fabrication and separation and recovery, $330,000

This estimate consists principally of revenues derived from special processing and fabrication services. Related cost of services included under the program "Other costs" is estimated to be $287,000.

1(b)(5) Income from security investigations, $300,000

This estimate covers income from authorized access permit holders for charges for security investigations. As a means of encouraging American industry to participate more fully in the atomic energy program, the Commission has instituted a program for release of selected classified nonmilitary information, after obtaining the necessary security clearances, to applicants who can demonstrate the information is needed in their business or profession. The estimated revenue is based on charging for all security investigations, with the exception of those for nonprofit educational institutions. On this basis, it is estimated that 5 percent of the security investigations in fiscal year 1961 will be provided without charge. The related cost for security investigations included under the program "Other costs" is $262,000.

1 (b) (6) Income from other services, $290,000

This estimate consists principally of revenues derived from services related to use of Commission laboratory services and equipment. Related cost of services included under the program "Other costs" is estimated to be $215,000.

2. Other revenue, $14,000,000

(a) Sale of source and special nuclear materials, $1,032,000.—This estimate includes revenue from sale of normal and enriched uranium to foreign countries, and domestic sale of normal and depleted uranium for industrial and research usage. Related costs of the products were included in program costs in prior years.

(b) Lease of source, special reactor, and nuclear materials, $2,350,000.—Current Commission policy provides for the lease of heavy water, for other than power reactors, and other materials to foreign countries and domestic users at a lease charge of 4 percent per annum. In certain cases it is anticipated that material will be sold to foreign countries rather than leased. The estimate includes the following income:

(a) Domestic	$1,750,000
(b) Foreign	600,000
Total	2,350,000

The revenue from domestic sources is principally related to lease of enriched materials for power reactors generating a revenue of approximately $1,450,000; materials leased for research and test reactors are estimated to provide a revenue of approximately $260,000; and additional revenue of approximately $40,000 is anticipated from the lease of normal uranium, plutonium and heavy water for research purposes. The revenue from foreign sources is related to lease of enriched materials for power reactors and research purposes of approximately $400,000 and lease of heavy water of approximately $200,000.

(c) Income from charges for special nuclear material consumed, $98,000.—This estimate includes revenue for charges for material consumed in reactor operators by military users. Current agreements with the Department of Defense provide that the Commission will be reimbursed for materials consumed in military reactors. Charges are based on the amount of fuel consumed. Estimates are based on scheduled reprocessing of cores and therefore estimates of revenue will differ from year to year.

(d) Income from sale of steam, $2,060,000.—This estimate consists of revenue from the sale of steam from the pressurized water reactor at Shippingport to the Duquesne Power & Light Co. and from the sodium reactor experiment (SRE) at Santa Susana, Calif., to the Southern California Edison Co. The fiscal year 1961 estimate assumes a higher level of operation for the PWR over the fiscal year 1960 level due to the reactor being down in fiscal year 1960 for an estimated 3 months for reseeding of the core.

(e) Income from research hospitals, $375,000.—This estimate includes income from patients at the Commission's research hospitals. Related costs for the operation of the hospitals are included under the biology and medicine program.

(f) Income from training, education, and information activities, $370,000.—This estimate includes revenue for tuition primarily from students attending the Argonne International School of Nuclear Science and Engineering at Chicago, the reactor supervisor course at Shippingport, Pa., and the reactor hazards evaluation and reactor supervisor courses at Oak Ridge and from the sale of technical publications, pamphlets, and other fees. The related costs for the schools are included under "Program costs." The increase in fiscal year 1961 over the fiscal year 1960 estimate is related principally to increases in student enrollment at the Argonne and Shippingport schools.

(g) Income from community operations, $5,697,000.—This estimate includes the income from the AEC community of Los Alamos and from housing and utilities furnished at Sandia, N. Mex., Monticello, Utah, and Grants, N. Mex. Aggregate income includes revenue from housing and commercial properties, including hospitals, income from municipal services, utility operations, and other miscellaneous sources. The community program schedules, included under the community program, reflect the revenue by community and category. Related

cost of $5,948,000 are included under program costs. The decrease in community revnue of $4,804,000 from the fiscal year 1960 estimate is due pricinpally to the disposal of revenue-producing housing, commercial and utility properties at Oak Ridge, Tenn., and Richland, Wash.

(*h*) *Income from collateral funds, $618,000.*—This estimate includes income from collateral funds held by contractors for insurance collateral, employee benefits, and annuity funds.

(*i*) *Other miscellaneous income, $1,400,000.*—This estimate includes income from royalties, insurance indemnity fees, and other miscellaneous sources of a general nature and is based on continuation of the fiscal year 1960 level.

Direct Employment, Travel, and Passenger Carrying Vehicles

Mr. Rabaut. "Miscellaneous." Insert pages 299 through 304.

All Programs—AEC Direct Employment

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimated fiscal year 1961
Number of permanent full-time civilian employees at end of fiscal year	6,719	6,876	6,958
Average number of permanent full-time civilian employees	6,746	6,803	6,908
Total personal services costs	$50,716,969	$52,284,000	$53,600,000

It is the basic policy of the Commission to conduct the atomic energy program through contractors to the greatest practical extent. The following functions are performed by AEC employees within this basic policy: (1) Program planning and direction, contract negotiation, liaison with contractors and inspection of contractor products; (2) administration of industrial development, licensing, and international cooperation activities; (3) security measures including screening of personnel, protection of documents and property, guarding of security shipments and patrolling of sites where contrators guard service is not provided; (4) evaluation of domestic and foreign raw materials resources; (5) operation of storage sites; (6) operation of the New Brunswick Laboratory and New York Health and Safety Laboratory; (7) operation and management of the Los Alamos communications facilities, and the fire and police department; (8) operation of health and safety activities at the National Reactor Testing Station in Idaho; (9) accounting, auditing, property management, and personnel services, assuring adequate controls by AEC offices and contractors; (10) control and dissemination of scientific and technical information; and (11) provision of supporting services at the AEC headquarters and field offices.

The fiscal year 1961 estimate provides for an increase of 82 permanent full-time employees over June 30, 1960, end strength of 6,876. Year-end strengths and average employment for permanent full-time employees and total personal services costs for each of the Commission's programs are shown in the following table:

Program	Actual, fiscal year 1959			Estimate, fiscal year 1960			Estimate, fiscal year 1961		
	Employment		Costs (in thousands)	Employment		Costs (in thousands)	Employment		Costs (in thousands)
	End strength	Average full time		End strength	Average full time		End strength	Average full time	
Raw materials	166	170	$1,392	163	165	$1,362	137	145	$1,199
Special nuclear materials	174	178	1,262	178	176	1,257	179	179	1,288
Weapons	1,039	1,067	6,787	1,062	1,052	6,947	1,068	1,065	7,151
Reactor development	219	209	1,327	228	224	1,457	240	235	1,550
Biology and medicine	86	85	679	95	91	700	95	95	722
Training, education and information	182	179	983	182	182	1,035	182	182	1,045
Community	107	120	778	98	103	699	87	87	500
Program direction and administration	4,746	4,738	37,509	4,870	4,810	38,827	4,970	4,920	40,085
Total	6,719	6,746	50,717	6,876	6,803	52,284	6,958	6,908	53,600

The net increase of 82 employees in fiscal year 1961 results from an increase of 100 employees for program direction and administration as outlined in the justification for operating costs under that program and a net decrease of 18 in other programs. The changes in other programs are discussed below:

(*a*) Raw materials program ..... −26
Reduction in the raw materials resources evaluation activities.

(*b*) Special nuclear materials program ..... +1

Weapons program ..... +6
Anticipated increase in volume and types of security shipments.

(*c*) Reactor development program ..... +12
An increase of 13 employees is required for the radiation telemetering system at the Idaho National Reactor Testing Station, offset by a reduction of 1 employee at the Chicago Operations Office due to anticipated reductions in security shipments.

(*d*) Community program ..... −11
Abolishment, effective June 30, 1960, of the Community Affairs Divisions at the Hanford and Oak Ridge Operations Offices in view of the assumption of city government functions by the incorporated cities of Richland, Wash., and Oak Ridge, Tenn.

U.S. Atomic Energy Commission

Fiscal year 1961 budget estimates appropriation, operating expenses—All programs, travel

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
Estimated number of travel days	101,086	114,737	124,310
Total estimated cost	$2,837,707	$3,339,000	$3,650,000

This estimate covers the cost of official travel of Government employees while discharging assigned AEC duties away from official duty stations. It is pointed out that the number of travel days and the travel costs reflect the travel of three principal classes of personnel: (1) AEC permanent full-time employees, (2) AEC intermittent employees such as members of advisory groups and individual consultants, and (3) about 280 military personnel on duty with the AEC, whose salaries are paid by the Department of Defense, but whose duties require considerable travel on AEC business. Some employees of the Commission spend the major part of their duty time away from their official station, such as shipment security guards in the special nuclear materials, weapons, and reactor development programs. Extensive travel is required in connection with weapons production, quality assurance inspections, and storage activities under the weapons program; inspection of licensed facilities; and international cooperation activities. Substantial travel is also required to maintain a satisfactory degree of technical and administrative supervision over Commission offices and projects and liaison with contractors, to provide for attendance of technical and scientific personnel at important domestic and foreign conferences and symposiums, and to provide for coordination of and participation in oversea nuclear energy exhibits.

The fiscal year 1961 request represents the estimated requirements for travel essential to the proper discharge of Commission responsibilities in all areas. The estimate for the raw materials program is related directly to the scope of the domestic and foreign resource evaluation programs. The estimates for the special nuclear materials and reactor development programs are related primarily to the volume of security shipments requiring escort personnel. The estimate for the weapons program is related to the projected level of operations which will necessitate a high volume of travel. The travel requested under the biology and medicine program is for required travel of personnel assigned to the New York Health and Safety Laboratory. A small amount of travel funds is required under the training, education, and information program by the technical information service extension at Oak Ridge. Under the community program limited travel will be performed by personnel engaged in community operations under the Albuquerque operations office. The estimate for program direction and administration was discussed in the justification for operating costs of that program.

The following table reflects a comparison of the estimated days of travel and estimated costs of the various programs:

[Costs in thousands]

Program	Actual, fiscal year 1959		Estimate, fiscal year 1960		Estimate, fiscal year 1961	
	Days	Cost	Days	Cost	Days	Cost
Raw materials	7,574	$120	8,423	$132	7,736	$124
Special nuclear materials	5,590	115	6,530	138	7,330	153
Weapons	27,612	422	30,069	513	32,892	557
Reactor development	3,416	69	4,839	100	5,367	105
Biology and medicine	737	28	1,153	45	1,282	50
Training, education, and information	167	6	167	6	167	6
Community	86	2	217	5	217	5
Program direction and administration	55,904	2,076	63,339	2,400	69,319	2,650
Total	101,086	2,838	114,737	3,339	124,310	3,650

U.S. Atomic Energy Commission

Fiscal year 1961 budget estimates—Statement on passenger carrying motor vehicles

	Actual fiscal year 1959	Estimate fiscal year 1960	Estimate fiscal year 1961
Net active fleet, end of fiscal year	2,046	2,024	2,044
Number of replacement vehicles	400	366	437
Number of additional vehicles	0	30	23
Gross cost of replacement vehicles	$1,032,132	$836,018	$1,687,406
Gross cost of additional vehicles	0	48,150	34,500
Total gross cost of vehicles	1,032,132	884,168	1,721,906

Passenger motor vehicles are required by the AEC for security patrols of extensive plant and laboratory areas, inspection and audit of Commission and contractor operated facilities, and for other necessary official transportation of AEC and contractor personnel within and between project sites and areas in the management and operation of the programs conducted by the agency.

Table A, below, shows the passenger motor vehicles requirements, by type, for fiscal year 1961. The estimate includes requirements for both contractor operations, and the AEC. The additional vehicles are required to support an increasing workload on the new production reactor at Hanford; expanding operations, including the high-energy physics program, and an increasing number of official visitors at Chicago; a need to augment the fleet at New York as a result of an expanded program and increased facilities; and expanding operations at the Idaho test site. All vehicles to be replaced meet or exceed the GSA replacement standards. A breakdown of the AEC fleet is shown in table B.

The fiscal year 1961 requirements provide for an increase of 34 automobiles. This increase is partially offset by 11 of these automobiles being replacements for station wagons. In addition, there is a decrease in the fleet of 3 buses making a net change in the passenger carrying fleet of 20 vehicles.

Table A.—*Passenger motor vehicle requirements*

	Actual, fiscal year 1959		Estimate, fiscal year 1960		Estimate, fiscal year 1961	
	Number	Cost	Number	Cost	Number	Cost
Automobiles	353	$532,000	338	$509,000	392	$593,000
Station wagons	21	40,168	30	58,500	17	33,150
Ambulances	5	36,249	5	37,520	4	27,916
Buses	21	423,715	23	279,148	47	1,067,840
Total requirements	400	1,032,132	396	884,168	460	1,721,906

TABLE B.—*Net active fleet of passenger motor vehicles at end of year*

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Automobiles	1,470	1,461	1,495
Station wagons	118	125	114
Ambulances	48	46	46
Buses	410	392	389
Total	2,046	2,024	2,044

NOTE.—The Atomic Energy Commission has an active program to promote more effective utilization of equipment, principally through increased use of AEC and GSA motor pools and, through this program, has been able to maintain its fleet of passenger motor vehicles at a fairly constant level even though operating programs have continued to expand.

Mr. RABAUT. Why do you need 23 new vehicles? Give us a breakdown in the record.

Mr. DERRY. I can give you a breakdown.

Mr. RABAUT. Indicate where you need them and what type vehicles are they going to be?

Mr. DERRY. Yes, sir.

(The matter referred to is as follows:)

NEED FOR ADDITIONAL PASSENGER MOTOR VEHICLES IN FISCAL YEAR 1961

The 23 additional vehicles required in fiscal year 1961 are automobiles of the lightweight class. Seven are required at Hanford in connection with the construction of the new production reactor; three will be required at the Argonne National Laboratory and eight at the Brookhaven National Laboratory to meet the laboratories' needs resulting from the expanding program and facility additions; and eight will be required at the National Reactor Testing Station, Idaho, because of the expanded operations at that site. Offsetting these additions will be a reduction of three vehicles at the Albuquerque operations office.

LANGUAGE CHANGES

Mr. RABAUT. Would you please discuss the changes to the operating expense appropriation language which you are proposing this year.

Mr. MCCARTHY. Yes, sir. In addition to the language on the accrued expenditure limitation, the language changes are briefly as follows:

(1) An increase in the amount of the limitation on travel expenses from $3,550,000 to $3,650,000;

(2) An increase in the amount of the limitation on personal services from $52,750,000 to $53,600,000;

(3) Authority to purchase 460 passenger motor vehicles of which 437 are for replacement only leaving the 23 additional that you mentioned and also including two vehicles at not to exceed $4,000 each; and finally,

(4) Inclusion of the amount to be appropriated for fiscal year 1961 of $2,427,300,000, and provision that this amount together with unexpended balances at June 30, 1960, of prior year appropriations shall remain available until expended.

The explanations of these changes are set forth on pages 10 through 12 of our justification material which have been inserted in the record. There is one additional language change not covered in the budget that I would like to bring up at this time. This relates to the language on newspapers and periodicals. In view of several GAO decisions

released on this matter, the most recent being January 4, 1960, it is apparent that the amount included in the clause, "purchase of newspapers and periodicals (not to exceed $6,000)," would either have to be increased materially or alternatively the clause deleted entirely. Our preference in this matter is the latter alternative.

ACTUAL 1960 COSTS

Mr. RABAUT. At this point, will you please insert into the record a tabulation showing for each of your operating programs actual 1960 costs through March together with your latest estimated projection for the balance of the fiscal year.

(The information referred to follows:)

[In millions of dollars]

	Actual costs through March 1960	Estimate for balance fiscal year 1960	Total estimate for fiscal year 1960
Raw materials	$544.4	$184.2	$728.6
Special nuclear materials	412.7	146.3	559.0
Weapons	359.8	138.3	498.1
Reactor development	262.8	122.2	385.0
Physical research	94.4	48.4	142.8
Biology and medicine	31.3	17.7	49.0
Training, education, and information	7.6	4.7	12.3
Civilian applications of isotopes and nuclear explosives	6.2	4.8	11.0
Isotopes program	2.7	1.3	4.0
Plowshare program	3.5	3.5	7.0
Community	10.7	3.9	14.6
Program direction and administration	37.6	13.7	51.3
Security investigations	4.8	1.7	6.5
Other costs	5.3	1.0	6.3
Total costs	1,777.6	686.9	2,464.5
Less: Revenues	−21.0	−5.4	−26.4
Net costs	1,756.6	681.5	2,438.1
Change in selected resources	201.9	−142.8	59.1
Total obligations	1,958.5	538.7	2,497.2

PLANT ACQUISITION AND CONSTRUCTION

Mr. RABAUT. Plant acquisition and construction, $215,500,000. Insert pages 305 through 348.

(The matter referred to is as follows:)

GENERAL STATEMENT FOR PLANT ACQUISITION AND CONSTRUCTION

SUMMARY OF REQUIREMENTS FOR FISCAL YEAR 1961

The budget estimates for the appropriation "Plant acquisition and construction" for the fiscal year 1961 provide for the total obligations of $221,600,000 to be funded by a new appropriation of $215,500,000 and by utilization of an unobligated balance of $6,100,000 estimated to be available at the close of fiscal year 1960. Of this amount, $47.2 million is requested for projects previously authorized, while the balance, $174.4 million, is required for projects for which authorization is now being requested.

A summarization of fiscal year 1961 obligations by program follows:

Summary of obligations for fiscal year 1961 by program

	Fiscal year 1961 obligations		
	Funding for projects already authorized	Funding for projects for which authorization is being requested	Total
Raw materials	0	$100,000	$100,000
Special nuclear materials	$25,000,000	31,966,000	56,966,000
Weapons	0	25,600,000	25,600,000
Reactor development	22,244,000	87,400,000	109,644,000
Physical research	0	23,000,000	23,000,000
Biology and medicine	0	4,300,000	4,300,000
Training, education, and information	0	150,000	150,000
Civilian applications of isotopes and nuclear explosives	0	0	0
Community	0	1,240,000	1,240,000
Administrative	0	600,000	600,000
Total obligations	47,244,000	174,356,000	221,600,000
Less unobligated balance brought forward			−6,100,000
Appropriation			215,500,000

Three-year summary of obligations and financing of obligations

The following tables summarize the total obligations incurred for each of the AEC's major construction program for fiscal year 1959, fiscal year 1960, and fiscal year 1961, and the sources of funding these obligations:

Summary of obligations by program

Program	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Raw materials	$78,717	$100,000	$100,000
Special nuclear materials	76,410,307	152,202,000	56,966,000
Weapons	36,800,220	38,112,000	25,600,000
Reactor development	130,705,216	196,122,500	109,644,000
Physical research	41,099,069	67,796,000	23,000,000
Biology and medicine	2,198,127	3,772,000	4,300,000
Training, education, and information	896,209	1,043,000	150,000
Civilian applications of isotopes and nuclear explosives	0	3,400,000	0
Community	2,282,149	3,227,000	1,240,000
Administrative	656,968	691,000	600,000
Total obligations	291,126,982	466,465,500	221,600,000

Summary of financing

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961
FUNDS AVAILABLE			
Unobligated balance at beginning of year	$222,864,482	$209,915,500	$6,100,000
Recovery of prior year obligations	28,249,000	150,000	0
Appropriations	249,929,000	262,500,000	215,500,000
Net amount available for obligation	501,042,482	472,565,500	221,600,000
Unobligated balance at end of year	209,915,500	6,100,000	0
Total obligations	291,126,982	466,465,500	221,600,000

Expenditures for plant acquisition and construction

Expenditures for plant acquisition and construction for fiscal year 1961 are estimated to be $280 million, an increase of $20 million over the estimate of $260 million in fiscal year 1960. Actual expenditures in fiscal year 1959 totaled $214,981,064. Unexpended balances are expected to decrease from $480,209,580 at the beginning of fiscal year 1959 to an estimated $453,157,516 at the end of fiscal year 1961 as shown in the following table:

	Actual, fiscal year 1959	Estimate, fiscal year 1960	Estimate, fiscal year 1961
Unexpended balance, beginning of year	$480,209,580	$515,157,516	$517,657,516
Appropriation	249,929,000	262,500,000	215,500,000
Total funds available	730,138,580	777,657,516	733,157,516
Less: Expenditures	214,981,064	260,000,000	280,000,000
Unexpended balance, end of year	515,157,516	517,657,516	453,157,516

HIGHLIGHTS OF CONSTRUCTION PROGRAMS

As shown in the table on page 305, estimates are presented on an obligation basis for construction requirements for each of the AEC's functional programs. The highlights of the estimates for new projects and previously authorized projects for which appropriations are required in fiscal year 1961 are as follows:

1. *Raw materials.*—Obligations for raw materials facilities in fiscal year 1961 are estimated at $0.1 million to provide for minor modifications and improvements to existing plant or installations of the Grand Junction, Colo., operations office.

2. *Special nuclear materials.*—Obligations for special nuclear materials facilities in fiscal year 1961 are estimated at $57 million and will provide $25 million for the balance of funding for the new Hanford plutonium production reactor; $5.4 million for production reactor improvements, $10 million for modifications to production supporting installations, $4.3 million for modifications to feed plants, $0.8 million for a gaseous diffusion development laboratory, and $11.5 million for general plant projects.

3. *Weapons.*—Obligations for weapons facilities in fiscal year 1961 are estimated at $25.6 million to provide $17.1 million for additional production capacity and research and development facilities, and $8.5 million for general plant projects.

4. *Reactor development.*—Obligations for reactor development facilities in fiscal year 1961 are estimated at $109.6 million, of which $87.4 million is for new projects to be authorized and $22.2 million is the balance of funding on previously authorized projects. Of $45.6 million for the civilian power program, $26.7 million is for the cooperative power reactor demonstration program, $6.9 million is for a fast reactor core test installation, $8 million is for the balance of funding for a power reactor of advanced design utilizing nuclear superheat authorized in 1960, and $4 million is the balance of funding for alterations and additions to Shippingport reactor facilities. In addition, $24 million is for an advanced test reactor; $24.7 million relates to military reactor and test projects, including funding of $8.5 million on the natural circulation prototype reactor in the Navy program; $6.3 million is for modifications and additions to general support facilities, and $9 million is for general plant projects.

5. *Physical research.*—Obligations for physical research facilities in fiscal year 1961 are estimated at $23 million to provide $12 million for construction of a high flux isotope reactor; $7.5 million for modifications and additions to existing research machines and laboratories; and $3.5 million for general plant projects.

6. *Biology and medicine.*—Obligations for biology and medicine facilities in fiscal year 1961 are estimated at $4.3 million to provide $4 million for the construction of facilities for support of biomedical research projects in atomic energy, and $0.3 million for general plant projects.

7. *Training, education and information.*—Obligations for training, education and information facilities in fiscal year 1961 are estimated at $150,000 to provide for general plant construction at the nuclear training center at Puerto Rico.

8. *Civilian applications of isotopes and nuclear explosives.*—No obligations for facilities for civilian applications of isotopes and nuclear explosives are planned for fiscal year 1961.

9. *Community.*—Obligations for community facilities in fiscal year 1961 are estimated at $1.2 million to provide $0.5 million for general plant projects at Los Alamos and Sandia; and the following projects at Los Alamos: $0.4 million for real estate development; $0.1 million for an elementary school addition; and $0.1 million for a steam transmission line.

10. *Administrative.*—Obligations for administrative facilities in fiscal year 1961 are estimated at $600,000 for general plant projects at headquarters.

EXPLANATION OF PROPOSED LANGUAGE CHANGES—PLANT ACQUISITION AND CONSTRUCTION

Proposed changes in language are indicated as follows (language enclosed in brackets indicates proposed deletions, and italic indicates proposed insertion of new language):

1. "[$262,500,000] *$215,500,000*".

The amount appropriated in fiscal year 1960 is deleted and the amount of the fiscal year 1961 appropriation request is inserted.

2. "*: Provided, That not to exceed $10,000,000 of this appropriation may be transferred to the appropriation for "Operating expenses", if the Commission determines such transfer is necessary to carry out the purposes of the cooperative power reactor demonstration program authorized under the Commission's authorization Act for the fiscal year 1961*"

The Commission's proposed 1961 authorization act would authorize additional appropriations in the amount of $40 million for the cooperative power reactor demonstration program. The operating expenses budget request includes $15 million of this amount and the remainder, $25 million, is requested in the estimate for plant acquisition and construction; this latter amount being for Commission construction of an organic-cooled and moderated reactor if there is no acceptable proposal under the cooperative power reactor demonstration program, or alternatively, should the utility industry construct this reactor, another reactor concept may become sufficiently developed to warrant prototype construction during the year.

In the event satisfactory proposals are received under the alternatives mentioned above, but it is necessary to provide for research and development assistance which is chargeable to the operating expenses appropriation, the proposed language would permit the transfer of not to exceed $10 million to that appropriation, upon Commission determination that such transfer is necessary to carry out the purposes of the cooperative power reactor demonstration program.

RAW MATERIALS PROGRAM—CONSTRUCTION OBLIGATIONS

Program statement

Estimated obligations, fiscal year 1961	$100,000
Estimated obligations, fiscal year 1960	100,000
Actual obligations, fiscal year 1959	78,717

Obligations for the raw materials program for fiscal year 1961 are estimated at $100,000. There follows the project and amount of the obligations for fiscal year 1961:

Project No.	Title	Total estimated cost	Funded through fiscal year 1960	Estimated obligations, fiscal year 1961	Funding required after fiscal year 1961 to complete project
61-j	General plant projects	$100,000	0	$100,000	0

Explanation of projects above

1. Project 61–j, general plant projects $100,000

This project is for minor capital improvements, alterations, additions, engineering, retirements, and minor new construction which are required to maintain the Commission-owned raw materials facilities in an efficient and safe operating condition.

SPECIAL NUCLEAR MATERIALS PROGRAM—CONSTRUCTION OBLIGATIONS

Program statement

Estimated obligations, fiscal year 1961	$56,966,000
Estimated obligations, fiscal year 1960	152,202,000
Actual obligations, fiscal year 1959	76,410,307

Obligations for the special nuclear materials program for fiscal year 1961 include $25 million for projects which are authorized but for which a request for appropriation was deferred until fiscal year 1961. There follows a listing of projects and amounts which comprise the obligations estimated for fiscal year 1961:

Project No.	Title	Total estimated cost	Funded through fiscal year 1960	Estimated obligations, fiscal year 1961	Funding required after fiscal year 1961 to complete project
61-a-1	Modifications to production and supporting installations.	$10,000,000	0	$10,000,000	0
61-a-2	Billet production plant	1,800,000	0	1,800,000	0
61-a-3	Heat treatment and inspection modifications, Fernald, Ohio.	2,500,000	0	2,500,000	0
61-a-4	Development laboratory building, Oak Ridge, Tenn.	766,000	0	766,000	0
61-a-5	Plutonium reclamation plant, Hanford, Wash.	2,900,000	0	2,900,000	0
61-a-6	Moderator purification improvements, Savannah River, S.C.	2,500,000	0	2,500,000	0
61-j	General plant projects	11,500,000	0	11,500,000	0
59-a-5	Production reactor facility for special nuclear materials, convertible type, Hanford, Wash.	145,000,000	120,000,000	25,000,000	0
	Total	176,966,000	120,000,000	56,966,000	0

EXPLANATION OF PROJECTS

1. Project 61–a–1, modifications to production and supporting installations, $10 million

This project provides for the design, procurement, fabrication and installation of equipment, together with the necessary plant modifications to existing facilities and/or construction of new facilities necessary to guarantee the continuity of operation, incorporation of technological advances, and increased safety of operations and assure the most economical operation of the production and supporting facilities under the administration of the Hanford, Savannah River, and Oak Ridge Operations Offices.

As in the case of the general plant projects, many of the items to be performed under this project cannot be identified specifically in advance, their need being predicated on the progress of process development work and changes in program requirements. Examples of work which may be done under this project are self-supported fuel element facilities, reactor modifications for self-supported fuel elements, new effluent systems, reduction of radiation exposure, heavy water conservation, underwater fuel element examination facilities, continuous denitration, high temperature test loops, and other items as the need arises.

2. Project 61-a-2, billet production plant, $1,800,000

This project provides production facilities necessary for the fabrication of billets for the Hanford new production reactor (NPR).

It may be possible to provide for this production by expanding an existing plant at Fernald now being used for production of slightly enriched uranium metal. However, construction of a new building with about 20,000 square feet of floor space, or modification of other plant facililties, may be necessary in order to prevent isotopic crossover. The new building may be constructed at a site other than Fernald.

In any event the modified facility will require equipment for at least three major process steps, reduction, recasting and machining, and necessary supporting services.

Since the first reactor loading for the NPR will be required in late calendar year 1962, the initial equivalent quantity of slightly enriched uranium billet will be required in early calendar year 1962; therefore, construction of this facility must begin in early 1961.

3. Project 61-a-3, heat treatment and inspection modifications, Fernald, Ohio, $2,500,000

This project provides for modifications of existing fuel element fabrication facilities at Fernald, Ohio, including such items as building additions and/or alterations, purchase of new equipment and relocation of existing equipment to permit process changes in the heat treatment and inspection facilities for fuel elements which are necessary to meet more stringent requirements of the production reactors. At present, efforts are being made to meet reactor sites specifications utilizing inefficient makeshift arrangements. There is need for heat treating, inspection and machining facilities designed specifically to meet current specifications and to provide some flexibility for coping with expected future changes in metal specifications.

4. Project 61-a-4, development-laboratory building, Oak Ridge, Tenn., $766,000

This project provides a new building to house the gaseous diffusion development laboratory. This new facility is needed to replace a wartime structure which is inadequate to meet the requirements of the present and future process development programs being carried out in support of the Oak Ridge and Paducah gaseous diffusion plants.

The improvements to be gained in work efficiency will result from elimination of inefficiencies in the present structure and by proper location of related facilities and functions. Improvements will also be gained in safety and fire protection by replacing the present temporary nonfireproof structures. The present development group working in the gaseous diffusion field, at Oak Ridge, are housed in separate buildings which are not functually suited to the nature of the work being carried out. Full coordination of effort cannot presently be realized even within one of the buildings due to the restrictions imposed by the design and construction of the building. The main building now being used as a laboratory was constructed 15 years ago and was not made fireproof due to the fact that it was only intended to serve as temporary housing for the original control laboratories. Maintenance costs for the building are increasing steadily. The handling of hazardous materials has introduced the hazards of fire and chemical reactions in a temporary frame-type building highly susceptible to total destruction. Not one of the laboratory rooms in the building is provided with an emergency exit for employees.

5. Project 61-a-5, plutonium-reclamation plant, Hanford, Wash., $2,900,000

This project will provide a new improved facility for reclamation of plutonium from both the wet and dry wastes which originate in the plutonium purification and fabrication operations.

6. Project 61-a-6, moderator purification improvements, Savannah River, S.C., $2,500,000

This project will provide improvements and additions to the moderator purification facilities in each of the five Savannah River plant reactor areas. The facilities will be designed to reduce the amount of particulate matter generated in the moderator-coolant and to reduce the turbidity in the moderator by removing radioactive particles.

7. Project 61–j, general plant projects, $11,500,000

This project provides for the accomplishment of numerous miscellaneous changes and additions to production processing and supporting facilities of the Oak Ridge, Hanford, and Savannah River operations offices. Work of this kind is required on a continuing basis to adapt the facilities to new production requirements and process improvements, to assure continuity of operations, to reduce maintenance and operating cost and to reduce or eliminate health or safety hazards.

The cost estimate for fiscal year 1961 is based on experience in prior years. Obligations in fiscal year 1960 will be approximately $10,400,000 for general plant construction. The estimate for this work in fiscal year 1961 is less than 1 percent of the capital value of all special nuclear materials plants under the jurisdiction of the Oak Ridge, Hanford, and Savannah River operations offices.

The amount requested for each operations office is as follows:

Operations office:	*Amount*
Oak Ridge	$8,000,000
Hanford	2,500,000
Savannah River	1,000,000
Total	11,500,000

8. Project 59–a–5, production reactor facility for special nuclear materials, convertible type, Hanford, Wash., $25 million

The additional funds requested for this project are to provide for continuation of construction of a graphite moderated water-cooled plutonium-production reactor designed for future conversion to power production. This project was authorized in fiscal year 1959 for $145 million and $120 million has been appropriated to date.

Weapons Program—Construction Obligations

Program statement

Estimated obligations, fiscal year 1961	$25,600,000
Estimated obligations, fiscal year 1960	38,112,000
Actual obligations, fiscal year 1959	36,800,220

A listing of projects and amounts which comprise the obligations estimated for fiscal year 1961 is as follows:

Project No.	Title	Total estimated cost	Funded through fiscal year 1960	Estimated obligations, fiscal year 1961	Funding required after fiscal year 1961 to complete project
61–b–1	Weapons production, development, and test installations.	$10,000,000	0	$10,000,000	0
61–b–2	High velocity test track, Sandia Base, N. Mex.	2,100,000	0	2,100,000	0
61–b–3	Special metals fabrication plant	3,000,000	0	3,000,000	0
61–e–1	Contaminated waste plant, Los Alamos, N. Mex.	2,000,000	0	2,000,000	0
61–j	General plant projects	8,500,000	0	8,500,000	0
	Total	25,600,000	0	25,600,000	0

EXPLANATION OF PROJECTS

1. Project 61–b–1, weapons production, development, and test installations, $10 million

This project provides for the construction and acquisition of such additional production, development and test facilities as may be required to further the weapons program. The specific nature of these facilities cannot be forecast at this time; however, the magnitude of the future production and development programs indicates that additional facilities will be required, either in the way

of increased plant capacity or added plant or facilities needed to cope with new techniques or both.

Similar projects in prior years have made it possible to proceed with the timely acquisition of facilities necessary to exploit research and development findings and to expand production activities. This project will assure availability of funds to meet new production requirements and to provide research, development and test facilities in order to take early advantage of advances or changes in the weapons field.

2. Project 61–b–2, high-velocity test track, Sandia Base, N. Mex., $2,100,000

This project provides for the construction of a test track of approximately 10,000 feet and supporting structures. The supporting structures include power outlet stations, setup shelter, and rain-erosion facilities.

The dynamic testing of materials and components is a vital link in the successful development of a weapon. Such tests include aerodynamic studies, environmental experiments, parachute-ejection studies, impact tests, safety experiments, and water-entry tests. The only facility available at Sandia to conduct these tests is a 3,000-foot track which is expensive to operate and technically inadequate. The major limitations which make the existing track unsuitable are: (1) inability to reach required speeds of mach 3 to 3.5, and (2) the time period during which high velocities can be maintained is insufficient to accumulate necessary dagnostic data. The proposed 10,000-foot track will make it possible to attain the required speeds and sustain the high velocities for a period of time sufficient to accumulate needed information.

Construction is scheduled to begin in the second quarter of fiscal year 1961.

3. Project 61–b–3, special metals fabrication plant $3 million

This project provides for a special metals fabrication plant required for weapons production which will consist of a machine-shop area, a press and salvage area, a brazing and annealing area, changehouse, lunchroom and administrative area. Major equipment items are vertical and horizontal lathes, a 1,000-ton press, resistant-type-vacuum furnaces and cleaning and salvage equipment.

4. Project 61–c–1, contaminated waste plant, Los Alamos, N. Mex., $2 million

This project provides for the construction of a plant for the treatment of chemically and radio-chemically contaminated liquid wastes generated by the metallurgical, chemical, biological, and cryogenical laboratories at the Los Alamos Scientific Laboratory. It will replace an existing disposal plant which was originally constructed as a pilot plant but through modifications has been able to handle the current load of 120 gallons per minute for an 8-hour day.

New and greatly augmented waste treatment requirements—estimated at 200 gallons per minute—are now projected based on laboratory facilities becoming available, primarily in the nuclear propulsion and power reactor programs, in 1960, 1961, and 1962. Furthermore, the existing plant was designed to handle plutonium and other alpha emitter wastes whereas the reactor program wastes contain mixed fission products and the present treatment system can remove only a small fraction of such wastes.

It is planned, therefore, that the new facility will have an estimated capacity of 250 gallons per minute and will consist of chemical treatment for the removal of alphat emitters followed by an ion-exchange treatment for removal of fission products. It will include facilities for consolidation and modest expansion of ecology and environmental research by the Laboratory's Radiological Physics Group, for continued waste disposal research by the Industrial Waste Group, and for radiological decontamination of equipment and materials by the Monitoring Group.

Construction of this plant is scheduled to begin in the first quarter of fiscal year 1961.

5. Project 61–j, general plant projects, $8,500,000

This project consists of miscellaneous improvements, alterations, additions, replacements and minor new construction of facilities required in the operation of production, research, development, and other facilities of the weapons program. In addition to installations normally covered under this project in prior years, new general plant requirements will be incurred in fiscal year 1961 at

the Lawrence Radiation Laboratory's remote high-explosive testing site and at the weapon modification centers.

This project is essential to continued safe and economical operations and to the accommodation of program advances. The increasing size of the weapons capital plant, the aging of many facilities, and rapid technological developments underscore the need for adequate general plant funds in the budget year.

REACTOR DEVELOPMENT PROGRAM—CONSTRUCTION OBLIGATIONS

Program statement

Estimated obligations fiscal year 1961	$109, 644, 000
Estimated obligations fiscal year 1960	196, 122, 500
Actual obligations fiscal year 1959	130, 705, 216

Obligations for the reactor development program for fiscal year 1961 include $22,244,000 for projects which are authorized, but for which a request for appropriation was deferred until fiscal year 1961. There follows a listing of projects and amounts which comprises the obligations estimated for fiscal year 1961:

Project No.	Title	Total estimated cost	Funded through fiscal year 1960	Estimated obligations, fiscal year 1961	Funding required after fiscal year 1961 to complete project
61-d-1	Additions and modifications to Chemical Engineering Building, Argonne National Laboratory, Ill.	$2, 000, 000	0	$2, 000, 000	0
61-d-2	Special-purpose-test installation addition, Santa Susana, Calif.	1, 200, 000	0	1, 200, 000	0
61-d-3	Technical space for SPERT, NRTS, Idaho.	500, 000	0	500, 000	0
61-d-4	Critical Building, Brookhaven National Laboratory, N.Y.	600, 000	0	600, 000	0
61-d-5	Fast reactor core test installation, LASL, New Mexico.	6, 900, 000	0	6, 900, 000	0
61-d-6	Plutonium fuel service and development building, LASL, New Mexico.	600, 000	0	600, 000	0
61-d-7	Test installation for Project Rover	20, 000, 000	0	13, 000, 000	7, 000, 000
61-d-8	Test installations for Project Pluto	15, 000, 000	0	2, 000, 000	13, 000, 000
61-d-9	Advanced test reactor	24, 000, 000	0	24, 000, 000	0
61-e-1	Additions and modifications, MTR-ETR area, NRTS, Idaho.	800, 000	0	800, 000	
61-e-2	Site utilities, Brookhaven National Laboratory, N.Y.	1, 250, 000	0	1, 250, 000	0
61-e-3	Quarters for visiting scientists, Brookhaven National Laboratory, N.Y.	550, 000	0	550, 000	0
61-109	Cooperative power reactor demonstration program.	25, 000, 000	0	25, 000, 000	0
61(j)	General Plant Project	9, 000, 000	0	9, 000, 000	0
60-e-11	Natural circulation test plant, NRTS, Idaho.	18, 500, 000	6, 000, 000	8, 500, 000	4, 000, 000
60-e-12	Alterations and additions to Shippingport reactor facilities.	9, 000, 000	5, 000, 000	4, 000, 000	0
60-e-15	Power reactor of advanced design capable of utilizing nuclear superheat.	11, 000, 000	3, 000, 000	8, 000, 000	0
58-111	Cooperative power reactor demonstration program.	49, 971, 000	38, 978, 000	1, 744, 000	9, 249, 000
	Total	195, 871, 000	52, 978, 000	109, 644, 000	33, 249, 000

EXPLANATION OF PROJECTS ABOVE

1. Project 61–d–1, additions and modifications to chemical engineering building, Argonne National Laboratory, Ill., $2 million

This project provides for such items as the extension of the Argonne National Laboratory Chemical Engineering Building and includes a provision for a gamma analyzer facility. It will provide chemistry laboratories to permit a much-needed extension of the program in the areas of pyrometallurgy, high-temperature processes and materials, plutonium and fluorine chemistry, etc. Existing laboratory areas are extremely crowded, and other areas have been converted to laboratory use to the maximum extent possible. The present crowding results in lack of space for additional equipment and personnel, hampers present programs, and limits the ability to undertake new work. The greatly needed gamma analyzer facility will be most economical to build as part of this construction.

2. Project 61–d–2, special purpose test installation addition, Santa Susana, Calif., $1,200,000

The purpose of this project is to provide testing capability for the SNAP program. It will include an additional power test cell and a transfer lock which have larger work areas, heavier shielding to accommodate higher radiation levels, and provision for dissipation of the greater heat rate. Necessary supporting building space and facilities will be provided to include machinery for greater heat removal capacity, additional mechanical-electrical and compressor room equipment, control room console, storage space, and utilities.

The SETF (SNAP Environmental Test Facility) has at present a capability of full system and simulated environmental testing of low-powered SNAP systems. The AEC has a requirement to extend the SNAP 2 reactor development to the 500-thermal-kilowatt range for certain advanced space missions. The new cell complex is required to permit full system testing of these units.

In addition to the higher power requirement, the number of SNAP 2 reactor application development programs necessitates the concurrent testing of units and therefore an increased testing capability. The objectives of high operational reliability for periods of 1 to 2 years in space missions is also requiring longer periods and testing as well as testing under a variety of simulated conditions.

Continued testing of SNAP 2 is necessary to support an orderly development of SNAP 8. The additional cell complex will permit the conduct of concurrent tests.

3. Project 61–d–3, technical space for SPERT, National Reactor Testing Station, Idaho, $500,000

This project provides for the design and construction of a building of approximately 10,000 square feet to be used as the control center for the SPERT project. This building will provide space for technical personnel and will include laboratory facilities and supporting areas.

The building is required to accommodate the expanded staff of technical and support personnel who are responsible for the SPERT program. The SPERT program involves two operating reactors at the present time and approximately 60 technical and administrative personnel. The staff will grow to approximately 110 people within the next 2 years as a result of the startup of SPERT 2 in 1959 and SPERT 4 in 1960. This growth will place an increased burden upon test operations, data reduction, and analysis of results. The staff is presently housed in a series of Butler buildings which are highly cramped with equipment, allowing only 45 square feet of office space for technical personnel. The SPERT program is the only major reactor program throughout the world which is completely devoted to the study of reactor safety and is vitally important in its role of eventually providing for safe and economical reactor power.

4. Project 61–d–4, critical building, Brookhaven National Laboratory, New York, $600,000

The BNL critical building will be attached to existing experimental reactor physics facilities. It will have an area of approximately 10,000 square feet and will contain a critical experiment area and a support area.

The critical experiment area will have a shielded critical assembly cell with a 30-foot clear ceiling height. The cell will be separated from the control console room by an entrance labyrinth. The shielding will be used to protect personnel in adjacent facilities from accidental radiation bursts.

The support area will contain office space, a shielded room for low-level counting, a vault for storing critical experiment fuel, an emergency power supply, a small boiler plant, and a basement storage area.

The BNL reactor physics program has produced a number of exponential experiments performed since 1951 and these have been the main U.S. source of fundamental experimental information on low enrichment, light water moderated reactor lattices. However, with the continual advance in sophistication and complexity of core design, modern reactor cores are no longer amenable to study by exponential experiment techniques. Many multiregion fuel loadings and nonuniform burnable poison distributions must be studied by critical experiment techniques. This facility is, therefore, essential to permit BNL to develop necessary reactor physics information for use in the design of reactor cores.

5. Project 61–d–5, fast reactor core test installation, Los Alamos Scientific Laboratory, N. Mex., $6,900,000

This project will provide a building and plant for the test operation of new types of fast reactor cores and the disassembly and analyses of such cores after operation. The projects consist of (*a*) building construction and (*b*) reactor fabrication and installation. Construction of the building is proposed for fiscal year 1961 for the purpose of housing the proposed LAMPRE II reactor installation. The building will be designed and constructed so that the succession of different core concepts can be studied with the minimum rearrangement of the main plant. It will be an economical industrial-type structure consisting probably of a structural steel frame with insulated cement asbestos siding or concrete masonry blocks which will match existing structures. One of the prime problems in the development of fast breeder cores is the attainment of high specific power and power density. Another is the development of liquid fuel container materials and fabrication methods suitable for the necessary high temperature and heat flux. This facility will permit testing of cores and materials to obtain data for the Commission's reactor program.

6. Project 61–d–6, plutonium Fuel Service and Development Building, Los Alamos Scientific Laboratory, N. Mex., $600,000

This project provides for an addition to the DP-West Plant at TA–21. The addition will be similar in construction and size to the other five buildings at this site and will be connected to them by a corridor.

To date, it has been possible to carry out small scale alloy-fuel development and to furnish the Lampre program with test alloys, using existing metal fabrication facilities. More elaborate experiments and more complex alloys of compositions suitable for a larger reactor of the Lampre type will preclude the use of the present fabrication line facility and will require additional space in which to fabricate fuel components for various tests for the expanded experimental program.

7. Project 61–d–7, test installation for Project Rover, $13 million

This project provides for the construction and modification of laboratory research facilities at Los Alamos, reactor field testing facilities at the Nevada test site, and such other facilities as may be required to support the Los Alamos Scientific Laboratory nuclear rocket propulsion program.

This project will provide (1) modifications, improvements, and expansion of existing structures to provide greater flexibility of use and to permit the conduct of low-power reactor experiments of advanced and improved reactors, and (2) new construction, including a test cell, and related support construction for experiments at higher power levels. A total of $20 million in authorization is requested; $13 million will be required in fiscal year 1961 and $7 million in future years.

8. Project 61–d–8, test installation for Project Pluto, $2 million

This project provides for the modification and additions to the existing Pluto test facility to accommodate the testing of the Tory II–C reactor experiment. The advanced Tory II–C reactor will be of the high-power, high-temperature, air-cooled type, and a considerably larger air supply to give the higher flow rates and longer durations will be necessary to meet these requirements. In view of the experimental nature of the program and the need for extensive environmental testing of the advanced reactor core, an additional test point is required.

The major element of cost is associated with the air storage and air heating systems. Modification of the disassembly facility and additional supporting facilities, utilities, roads and paving also will be required.

The proposed facilities will be designed to accommodate the testing of the advanced reactor cores for Tory II–C.

A total of $15 million in authorization is requested; $2 million will be required in fiscal year 1961 and $13 million in future years.

9. Project 61–d–9, advanced test reactor, $24 million

This project provides for construction of an advanced test reactor to provide high fluxes. High fluxes are required for the Commission program to develop high performance naval and power reactors. The design power level of the reactor has not been established. However, a conceptual design study is underway to establish the parameters for an advanced test reactor.

It is intended that the reactor will be optimized to meet pressurized water reactor test requirements.

10. Project 61–e–1, additions and modification, MTR–ETR area, National Reactor Testing Station, Idaho, $800,000

This project will consist of a structure of approximately 31,000 square feet, including a basement of 1,000 square feet to house heating and mechanical equipment, to provide workspace for approximately 200 engineering, draftsman, and sponsor representatives presently housed in several remote and crowded facilities, as well as storage vault space for the technical library.

11. Project 61–e–2, site utilities, Brookhaven National Laboratory, New York, $1,250,000

This project consists of two parts: (*a*) increase in the carrying capacity of steam lines of the steam heating distribution system to correspond to the increased demands and increased steam generating capacity of the central steamplant, and (*b*) doubling the capacity of the main transformer substation of the electrical distribution system and extending and enlarging the underground duct bank system.

The immediate specific need is concerned with the utilities for projects presently underway or recently completed (e.g. AGS accelerator, Cosmotron target area) or for authorized buildings and projects which will be either in the active design stage or under construction in the coming year (e.g. research reactor, physics building, nuclear engineering building).

12. Project 61–e–3, quarters for visiting scientists, Brookhaven National Laboratory, New York, $550,000

This project provides for the construction and furnishing of 56 apartment units to be located near existing temporary apartments on the outskirts of the Brookhaven National Laboratory. These apartments are necessary primarily to meet the housing demands of visiting scientists, and will also be utilized for laboratory staff employed on an "on-call" basis.

The Laboratory is located in a remote area of Long Island, N.Y., where houses and apartments are not generally available on a short-term rental basis. A principal objective of the Laboratory is to make its unusual and extensive research facilities available to the scientific community as a whole. The Laboratory has therefore encouraged scientists from universities, industry, Government laboratories, and other institutions to work at BNL for extended periods of time. As a result of this highly effective program, more than 500 visiting scientists spend 1 month or more at the Laboratory each year. These include approximately 300 mature scientists from other institutions, between 75 and 100 postdoctoral research associates, 30 graduate students working on doctoral theses, and 100 students participating in summer programs. The average attendance from all sources is approximately 225 with a peak during the summer months.

This program is extremely valuable from several standpoints. It gives the Laboratory the services of large numbers of experienced scientists whose presence not only augments the work accomplished but also contributes important intangible benefits from the exchange of ideas. The experience and training acquired by the younger visitors greatly strengthens the total national scientific program through the increased effectiveness of the visitors when they return to their home institutions. Furthermore, in many instances universities are able to attract and keep distinguished scientists because of the research opportunities afforded at Brookhaven.

13. Project 61(j), general plant projects, $9 million

The work contemplated under this project consists of many miscellaneous improvements, alterations, and additions, including minor new construction. Similar work is performed annually in order to provide for continuity of operations, improvement to techniques, and reduction in operating costs in the various facilities of the reactor development program.

14. Project 61–109, cooperative power reactor demonstration program, $25 million

This project provides for an additional amount under the cooperative power reactor demonstration program. These funds would be used to construct an intermediate size organic-cooled reactor should the invitation to the utility industry to construct such a reactor not be accepted. Alternatively, should the utility industry construct this reactor, another reactor concept may become sufficiently developed to warrant prototype construction during the year. Such possibilities include construction of a spectral shift pressurized water reactor, or construction of a small reactor at a remote location.

15. Project 60–e–11, natural circulation test plant, National Reactor Testing Station, Idaho, $8,500,000

This project, for which an authorization of $18,500,000 and an initial appropriation of $6 million were provided in fiscal year 1960, covers the construction of a facility necessary for full-scale operation and testing of a natural circulation reactor plant for naval ship propulsion. The plant will consist of a reactor, primary coolant system, essential controls and instruments. The AEC has a requirement from the DOD to undertake the early development and test of such a plant.

A natural circulation reactor plant offers promise of a significant advance in the field of pressurized water reactors for naval ship propulsion because of (1) inherent safety expected in testing and operation of a reactor plant, (2) plant simplification, and (3) increased reliability. The design of a reactor for a natural circulation plant differs considerably from forced circulation pressurized water reactor design. As a result, developmental problems are introduced which require construction of a full-scale test plant. To date the development of this type reactor plant has been confined to analytical studies and small-scale out-of-pile experimental tests. A facility is now required where full-scale tests can be conducted to evaluate the performance and suitability of this type plant for naval ship propulsion.

The $6 million appropriated in 1960 will be obligated for design and procurement of long lead items as well as minor site construction. The amount of $8,500,000 will be required in fiscal year 1961 and the balance of $4 million in fiscal year 1962 for completion of construction.

16. Project 60–e–12, alterations to Shippingport reactor facilities, $4 million

This project, for which an authorization and appropriation of $5 million was provided in fiscal year 1960, has been revised in scope to include provision for dissipation of excess steam. The revised cost estimate is $9 million requiring appropriation of $4 million in fiscal year 1961.

This project provides for the modification of the Shippingport Atomic Power Station to permit operation at a lower level sufficient to generate 150 MW gross electrical output. Modifications will consist of required changes in certain components and systems of the reactor plant, primarily pressurizer and pressure relief system, steam generators and instrumentation and control systems and provision for dissipation of excess steam above present generating capacity which is now rated at 100 MWE.

The Shippingport plant was constructed to obtain information relative to the design, operations, and maintenance of central station nuclear powerplants with the primary objective of advancing general power reactor technology. The development of longer life, high power density cores is a major goal of this effort. Core No. 2 is of such a design that it is expected that this core will have sufficient capacity for generation of approximately 150 megawatts gross electrical output. In order to take advantage of the higher anticipated performance of core 2 and to demonstrate the maximum power capability of the reactor installed in the Shippingport plant, it is necessary to make these modifications.

17. Project 60–e–15, power reactor of advanced design capable of utilizing nuclear superheat, $8 million

This project, for which an authorization of $11 million and an appropriation of $3 million were provided in fiscal year 1960, covers the construction of a power reactor of advanced design to demonstrate advanced concepts indicating potential of early reduction of cost of nuclear energy as a source of commercial power.

Nuclear superheat is a natural evolutionary development step from the boiling water concept, and its development is desirable from the standpoint of increased cycle efficiency of the resulting plant. The feasibility of nuclear superheat requires the same type of demonstration experience as accrued on boiling water reactors. A small superheat demonstration plant will provide a basis for extrapolation to somewhat larger plant sizes with a minimum of investment and risk. Early operation of such a plant will provide valuable data needed to clarify the relative significance and feasibility of superheat in future water reactor programs.

During fiscal year 1960 a total of $3 million will be obligated for engineering, design, and procurement of the pressure vessel; the remaining $8 million will be required in fiscal year 1961 for reactor plant construction.

18. Project 58–111, cooperative power reactor demonstrating program, $1,744,000

The cooperative power reactor demonstration program was initiated in accordance with the Atomic Energy Act of 1954, to encourage widespread participation in the development and utilization of atomic energy for peaceful purposes and to stimulate industrial participation in the development and application of nuclear technology to the generation of power for civilian uses.

This project provides for construction of reactor portions of demonstration nuclear plants, through various arrangements with participant public utilities and equipment manufacturers under the cooperative arrangements program. The total estimated cost for construction under this project is $49,971,000, of which $38,978,000 has been appropriated through fiscal year 1960. The amount of $1,744,000 is required in fiscal year 1961 for continuation of construction on the consumers public power district project. The balance of $9,249,000 may be required in future years, for another project.

Physical Research Program—Construction Obligations

Program statement

Estimated obligations fiscal year 1961	$23,000,000
Estimated obligations fiscal year 1960	67,796,000
Actual obligations fiscal year 1959	41,099,069

Obligations for the physical research program for fiscal year 1961 include only projects for which authorization is proposed in fiscal year 1961. There are no previously authorized physical research projects for which a request for appropriation was deferred until fiscal year 1961. There follows a listing of projects and amounts which comprise the obligations estimated for fiscal year 1961:

Project No.	Title	Total estimated cost	Funded through fiscal year 1960	Estimated obligations, fiscal year 1961	Funding required after fiscal year 1961 to complete project
61-f-1	Bubble chamber house, Brookhaven National Laboratory, N.Y.	$1,660,000	0	$1,660,000	0
61-f-2	Princeton-Pennsylvania accelerator addition, Princeton, N.J.	10,820,000	0	1,350,000	$9,470,000
61-f-3	Accelerator and reactor additions and modifications, Brookhaven National Laboratory, N.Y.	1,085,000	0	1,085,000	0
61-f-4	High flux isotope reactor, Oak Ridge National Laboratory, Tenn.	12,000,000	0	12,000,000	0

Project No.	Title	Total estimated cost	Funded through fiscal year 1960	Estimated obligations, fiscal year 1961	Funding required after fiscal year 1961 to complete project
61-f-5	Accelerator improvements, Lawrence Radiation Laboratory, Calif.	$500,000	0	$500,000	0
61-f-6	Major bevatron improvements, Lawrence Radiation Laboratory, Calif.	9,600,000	0	1,750,000	$7,850,000
61-g-1	Metallurgy building extension, Brookhaven National Laboratory, N.Y.	655,000	0	655,000	0
61-g-2	Addition to cyclotron building, Lawrence Radiation Laboratory, Calif.	500,000	0	500,000	0
61-j	General plant projects	3,500,000	0	3,500,000	0
57-a-1	High energy accelerator, Argonne National Laboratory.	42,000,000	$29,000,000	0	13,000,000
	Total	82,320,000	29,000,000	23,000,000	30,320,000

EXPLANATION OF PROJECTS

1. Project 61–f–1, bubble chamber house, Brookhaven National Laboratory, N.Y., $1,660,000

This project covers the construction of a building to house the 80-inch bubble chamber, an accelerator tunnel conjunction section necessary to bring elementary particle beams to the bubble chamber, the required exterior yard areas, and site and utility work.

Liquid hydrogen bubble chambers are among the most powerful tools for experimentation in high energy physics. A chamber of dimensions 80 by 25 by 20 inches is now being built at BNL for use at the alternating gradient synchrotron (AGS). In this chamber, production, interactions, and properties of elementary particles, such as nucleons, mesons, and "strange" particles, are to be studied in liquid hydrogen and deuterium. The large size of the chamber is dictated by the high energies, made possible by the AGS, of many of the particles which are to be studied.

The bubble chamber will reach the testing stage in fiscal year 1961 and a structure to house it as well as its auxiliary equipment is required. The bubble chamber and auxiliary equipment will be so large that it cannot be placed inside the existing AGS target building as it would interfere seriously with the array of magnets necessary to provide beams, and with other experiments.

2. Project 61–f–2, Princeton-Pennsylvania accelerator addition, Princeton, N.J., $1,350,000

A total of $10,820,000 is required for authorization in fiscal year 1961 to provide for construction of a new administrative, maintenance, and laboratory wing, a new storage building, external beam facilities, and and an extension to the experimental meson area. Of this amount, $1,350,000 is required for obligation in fiscal year 1961 for the additional wing and the storage building. The balance of $9,470,000 will be requested in subsequent years.

The new wing will be a two story, central corridor, air-conditioned building designed to house the operating and maintenance staff, purchasing department, machine shop, administrative staff, and some of the laboratories and experimental facilities. The storage building will be a single story structure with an area of about 20,000 square feet and will cost about $110,000.

A new wing is needed because the present office and laboratory building is already 100 percent occupied by accelerator engineering staff, administrative staff, and supporting functions numbering 96 people. An increase in staff of approximately 30 faculty members and 20 graduate students by July 1960 is expected.

These physicists are now planning experiments at the University of Pennsylvania and Princeton, but will have to be accommodated at the accelerator if they are to function most effectively. The present building of 28,000 square feet, being immediately adjacent to the accelerator proper, is the ideal place to house the scientific staff and their complex experimental equipment.

A new storage building is needed since at the present time there is no storage area available of sufficient size to store bulk materials and auxiliary equipment temporarily out of use.

3. Project 61–f–3, accelerator and reactor additions and modifications, Brookhaven National Laboratory, N.Y., $1,085,000.

This project provides for recurring annual projects of varying magnitude to take care of necessary additions, modifications, and improvements to Brookhaven's major research machines: the graphite research reactor, the cosmotron, and the alternating gradient synchrotron (AGS). Because of the rapid advancements in accelerator technology, the specific jobs to be undertaken cannot be determined in advance. The improvements proposed are based on a logical progression of modification and refinement of the instruments consistent with program requirements.

The additions and adjustments provided by this project will increase the utilization of the laboratory's machines and the scope and type of experiments that can be conducted with each of the two accelerators and the reactor.

4. Project 61–f–4, high flux isotope reactor, Oak Ridge National Laboratory, Tenn., $12,000,000

This project provides for construction at ORNL of a high flux reactor of the flux-trap type operating at a design power of 100 megawatts with a maximum flux in the region of 3–5 by 10^{15} neutrons per square centimeter per second for the production of transuranic elements and special isotopes of the lighter elements. The high flux isotope reactor (HFIR) will serve as a national facility for the production of transuranic elements. In addition, the project will provide ORNL with a means for expanding and improving its radioisotope program.

The importance of high neutron flux research reactors for the production of heavy elements such as californium 252 and other isotopes, for radiation damage experiments, and for neutron beam research has been actively discussed in the national laboratories and other U.S. laboratories for some time. It has been determined that an isotope producer reactor should be designed and constructed at ORNL. This decision on location was based on (1) availability of facilities for processing and distributing the products of the irradiation, (2) availability of fuel reprocessing facilities, (3) the recognition that ORNL is a national center for isotope research and development, and (4) interest in the laboratory in constructing the reactor. This reactor would serve as the first AEC-wide high flux facility and will be operated in conjunction with the national heavy element production program.

5. Project 61–f–5, accelerator improvements, Lawrence Radiation Laboratory, Calif., $500,000

This project provides for improvements and additions to two of the major operating Berkeley accelerators, namely, the 184-inch cyclotron, and the heavy ion linear accelerator. The requested improvements and additions are primarily of an experimental nature, involving a varied application of engineering-design and equipment usage, including equipment installation for varying periods of time. The improvements proposed are based on current planning and are subject to revision as programmatic activity develops. Priorities will be determined by experimental needs. Overall planning for accelerator improvements is based on a logical progression of modification and refinement of the instruments consistent with program requirements. From experience gained through operation of the Berkeley accelerators it is clear that the effectiveness of these machines cannot be realized in their full scientific potential without continuous modification to maintain the pace of physical and technological advancements.

6. Project 61–f–6, major bevatron improvements, Lawrence Radiation Laboratory, Calif., $1,750,000

A total of $9,600,000 is required for authorization in fiscal year 1961 to provide for increased beam intensity, additional experimental facilities, and new external

primary and secondary beams. Of this amount, $1,750,000 is required for obligation in fiscal year 1961 for design, fabrication, and erection of additional bevatron shielding necessary to provide adequate protection from radiation levels, and for initiation of machine modifications.

The work will consist of initial machine modifications, flood alterations, foundations, shielding, roof supports in the injector and wind tunnel area, and roof alterations necessary to accommodate the heavy loads of the planned shielding.

The additional shielding is essential for the proposed higher beam intensity since the maximum beam intensity of 2 by 10 inch protons per pulse sustained at 10 pulses per minute currently produces the maximum radiation level permissible for personnel.

7. Project 61–g–1, metallurgy building extension, Brookhaven National Laboratory, N.Y., $655,000

This project consists of two parts: modifications to the existing building and construction of an addition to the building. The existing metallurgy building (bldg. 480), to which this proposed project will be attached, is a cement block structure, built by the Army as a Camp Upton gymnasium, and modified by the Laboratory for metallurgy work in 1951. The existing building has a gross area of 17,200 square feet. The modifications to the existing building will consist largely of partition work, including new doors and windows where required, and rearranging utilities (water, gas, steam, electric power, drains, etc.) as required to accommodate the new functions in these spaces. The extension will be made at the eastern, two-story end of the existing building, and will be a two-story structure having a gross area of 12,200 square feet.

The proposed addition to the metallurgy building and the modifications to existing spaces are intended to provide facilities not now included, and also to relieve the severe overcrowding of existing facilities.

8. Project 61–g–2, addition to cyclotron building, Lawrence Radiation Laboratory, Calif., $500,000

This project comprises an additional 9,000 gross square feet of experimental area for the 184-inch cyclotron by providing an addition to the existing building 6. The addition will be an extension of the southern side of the present building by 32 feet through approximately 128° of arc.

The experimental physics program and the 184-inch cyclotron activity are severely limited by insufficient experimental space in the existing building. The machine has not been able to attain its maximum operating level, nor have the experimenters been able to achieve the maximum yield of information from the instrument. At present, the feasibility of an experiment is controlled not by its scientific importance or the capacity of the cyclotron to carry it through, but whether there is adequate space to set up the necessary equipment. This kind of limitation is one that can and should be eliminated to take full advantage of manpower and machinery.

9. Project 61–j, general plant projects, $3,500,000

This project provides for the minor and often individually unpredictable capital improvements, modifications, and additions that are required for the Oak Ridge National Laboratory, the Ames Laboratory, and the contract physical research program. The modifications and improvements that are made possible by this request are important to continued progress in the Commission's research and development program. The general plant project funds requested for fiscal year 1961 will be used as follows:

Oak Ridge National Laboratory	$1,800,000
Ames Laboratory	50,000
Cambridge and Princeton projects	1,200,000
Contract-research program	450,000

Biology and Medicine Program—Construction Obligations

Program statement

Estimated obligations, fiscal year 1961	$4,300,000
Estimated obligations, fiscal year 1960	3,772,000
Actual obligations, fiscal year 1959	2,198,127

Obligations for the biology and medicine program for fiscal year 1961 are estimated at $4,300,000, all of which are for new projects justified below.

Project No.	Title	Total estimated cost	Funded through fiscal year 1960	Estimated obligations, fiscal year 1961	Funding required after fiscal year 1961 to complete project
61-h-1	Installations for Support of Biomedical Research in Atomic Energy	$4,000,000	0	$4,000,000	0
61-(j)	General Plant Projects	300,000	0	300,000	0
	Total	4,300,000	0	4,300,000	0

EXPLANATION OF PROJECTS ABOVE

1. Project 61-h-1, installations for support of biomedical research in atomic energy, $4,000,000

This project provides for construction, alteration, and modification of laboratory and animal holding installations as may be required for support of biomedical research in atomic energy. Existing Commission supported laboratories are in many instances inadequate for the conduct of biomedical research programs required for the initiation or expansion of investigations of the effects of radiation on biological systems and hazards associated with radioactive fallout and other atomic energy operations. These laboratories will be enlarged where required, and other installations will be provided when existing facilities are not available, or adequate.

The need for expansion of installations required for support of biomedical research programs has been emphasized during the hearings conducted in May 1959, by the Joint Committee on Atomic Energy updating information on radioactive fallout and defining new problems requiring further investigation. Studies planned include research on the production of tumors with chronic doses of radiation, experimental radiation dosimetry and animal radiobiology using fast neutrons only slightly contaminated by gamma radiation and in a short pulse time, effects of small amounts of irradiation on longevity, biochemical and genetic effects of radiation at the cellular level, and effects of inhalation of mixed fission products. Most of these projects require unique installations for delivery of radiations and for retention of experimental animals and other biological materials for long periods of time.

2. Project 61-(j), general plant projects, $300,000

The purpose of this project is to provide for miscellaneous alterations, improvements, and minor additions to general plant and research installations of the biomedical research program necessary to improve efficiency of operation, correct safety and security hazards and facilitate advances in research. The estimate, based on past experience as to requirements, will cover the necessary improvements at Commission operated laboratories in the life sciences, as well as minor construction or alterations required by biology and medicine Commission supported research at universities and other research institutions.

Training Education and Information Program—Construction Obligations

Program statement

Estimated obligations fiscal year 1961	$150,000
Estimated obligations fiscal year 1960	1,043,000
Actual obligations fiscal year 1959	896,209

Obligations for the training, education and information program for fiscal year 1961 are for projects for which authorization is being requested in the fiscal year 1961 authorization act. There follows a listing of projects and amounts which comprise the obligations estimated for fiscal year 1961:

Project No.	Title	Total estimated cost	Funded through fiscal year 1960	Estimated obligations, fiscal year 1961	Funding required after fiscal year 1961 to complete project
61-j	General plant projects	$150,000	0	$150,000	0
	Total	150,000	0	150,000	0

EXPLANATION OF PROJECT ABOVE

1. Project 61–j, general plant projects, $158,000

This project provides for capital construction items that are not of sufficient individual magnitude to constitute separate line item construction projects. These items include required improvements, alterations and additions to the training and research facilities of the Puerto Rico Nuclear Center which is operated for the AEC by the University of Puerto Rico. The known items of work expected to be required in fiscal year 1961 are as follows: Construction of a weather station at the Mayaguez site; fencing of the Mayaguez site; building of a Government-owned 38-kilovolt to 4.16-kilovolt substation with metering at 38 kilovolts; building a gamma irradiation facility in connection with the biomedical building; and other miscellaneous items. Such additions and improvements will contribute to the efficiency and safety of operations and will contribute to making the center a better facility for training and research.

COMMUNITY PROGRAM—CONSTRUCTION OBLIGATIONS

Program statement

Estimated obligations fiscal year 1961	$1,240,000
Estimated obligations fiscal year 1960	3,227,000
Actual obligations fiscal year 1959	2,282,149

Obligations for the community program for fiscal year 1961 are estimated at $1,240,000 for the projects listed below:

Project No.	Title	Total estimated cost	Funded through fiscal year 1960	Estimated obligations, fiscal year 1961	Funding required after fiscal year 1961 to complete project
61-i-1	Real estate development, Los Alamos, N. Mex.	$435,000	0	435,000	0
61-i-2	Elementary school addition, Los Alamos, N. Mex.	145,000	0	145,000	0
61-i-3	Steam transmission line, Los Alamos, N. Mex.	135,000	0	135,000	0
61-j	General plant projects	525,000	0	525,000	0
	Total	1,240,000	0	1,240,000	0

EXPLANATION OF PROJECTS ABOVE

1. Project 61–i–1, real estate development, Los Alamos, N. Mex., $435,000

This project provides for the development of 73 additional lots on Barranca Mesa, which lies immediately north of, and in proximity to, the main Los Alamos community. The development has been designed to conform with FHA subdivision requirements as to physical improvements, utilities, and lot layout. The estimate covers the cost of providing the necessary utilities, roads, and lot development.

Adequate housing has long been known to be a prime consideration in the attraction and retention at Los Alamos of the high caliber technical and scientific personnel required to conduct the programs at the Laboratory. This project, which continues a program now underway, will enable Los Alamos personnel to build the size and type of housing they desire. Moreover, it will make it possible for laboratory personnel to spend their full working careers at Los Alamos with assurance of being able, upon retirement, to remain residents of the community. The program has the further advantage of partially meeting the need for improved housing at Los Alamos on a basis which will permit the Government to recover development costs through revenues from sale of lots and utilities.

This project is the third increment of the lot development on Barranca Mesa. The first increment has just been completed and all 72 lots sold. Development of the second increment (47 lots) has begun.

2. Project 61–i–2, elementary school addition, Los Alamos, N. Mex., $145,000

This project provides for an addition to the Mountain Elementary School of four special purpose classrooms, having a total area of approximately 7,200 square feet. Space currently used for such activities is substandard in size (3,000 square feet) and type of space in comparison to other Los Alamos schools. In addition, it is expected that the enrollment at the Mountain School will have increased by 100 students by the time the addition is complete. This addition will therefore permit converting the space now used back to regular classrooms which will be needed for the enrollment increase as well as to correct deficiencies in the special classroom needs.

3. Project 61–i–3, steam transmission line, Los Alamos, N. Mex., $135,000

The steam requirements of the central community area are now met by a small plant constructed in 1948. The cost of producing steam at this plant is $1.51 per 1,000 pounds as compared with a cost of $0.31 per 1,000 pounds at another steamplant which has been recently completed in a nearby technical area. This project will provide for the construction of approximately 3,500 feet of steam line, thereby making it possible to serve the central community area with steam from the technical area and place the small plant in standby. This change will reduce annual operating costs by approximately $45,000.

4. Project 61–j, general plant projects, $525,000

This project covers alterations, additions, replacements and other general improvements to schools, city streets, sewerage systems, municipal sites, water and electrical distribution systems, housing, business concession, hospital and other community facilities in order to adequately maintain the Los Alamos and Sandia communities. Normal operating requirements in past years indicate a continuing need for numerous capital items each year in order to provide continuing economical operation of the communities.

ADMINISTRATIVE PROGRAM—CONSTRUCTION OBLIGATIONS

Program statement

Estimated obligations fiscal year 1961	$600,000
Estimated obligations fiscal year 1960	691,000
Actual obligations fiscal year 1959	656,968

Obligations for the administrative program for fiscal year 1961 are estimated at $600,000 for the project listed below:

Project No.	Title	Total estimated cost	Funded through fiscal year 1960	Estimated obligations, fiscal year 1961	Funding required after fiscal year 1961 to complete project
61-j	General plant projects	$600,000	0	$600,000	0

EXPLANATION OF PROJECTS ABOVE

This project covers alterations, additions, replacements, and other general improvements of various types at the headquarters in Germantown, Md., including shelter area improvements. Normal operating requirements create a need for numerous capital items each year, many of which are of a recurring nature, for reasons of economy, safety, health protection, and efficient operation.

ANTICIPATED SUPPLEMENTAL

Mr. RABAUT. There are several items in the plant and construction program which the Joint Committee has included in the authorization bill, but for which no funds are budgeted. Please review these items and tell us if you plan to request funds for them in the supplemental.

Do you have those items before you, sir?

General LUEDECKE. Yes, sir. With respect to the Stanford linear accelerator, the Chairman mentioned in his opening statement that no funds are included in this budget and if authorized would be requested by supplemental.

With respect to the $13 million for the powerplants authorized for Antarctica, as reported out for Antarctica, the Commission stands ready to support the using agency in going ahead with this authorization. The authorization provided that they might be funded by means other than the Commission.

With respect to the two university buildings, if they were authorized we would expect to go ahead, I think, with preliminary design and project scoping.

Mr. RABAUT. Do you want to give the other items now?

General LUEDECKE. I believe that was all, sir, except the $1 million increase in facilities for biology and medicine. The $4 million that we asked for there is for contingency construction. We do not know now the specific projects for which the money would be spent.

Mr. RABAUT. How much is involved, $4 million?

General LUEDECKE. $4 million was in our original request. The authorization bill provides for an additional $1 million.

Mr. RABAUT. Off the record.

(Discussion off the record.)

LABORATORIES AT UNIVERSITY OF ILLINOIS AND NOTRE DAME

Mr. RABAUT. With respect to the materials testing laboratories at the University of Illinois, and at Notre Dame, is it not true that the Advanced Research Projects Agency in the Defense Establishment is engaged in an extensive program of materials research which includes the establishment of university laboratories?

General LUEDECKE. They are engaged in a wide program of materials research and have been of considerable assistance to certain laboratories. The extent to which they are going ahead with this I am not able to say.

Mr. RABAUT. I would like to quote from our Defense Subcommittee hearings on March 6 of this year. General Betts stated:

About the Advance Research Projects Agency if the Congress and the administration go along with the ARPA's program proposal that we fund this at about $17 million per year I would predict that next year we would pick up an additional three universities. The following year an additional three, and that this is about where ARPA would have to end unless people would want to raise a desire for larger packages than most of the basic research support that is now being given universities.

We are talking about an interdisciplinary laboratory where we do not limit this to the department of physics, chemistry or the department of mineralogy. We will ask the university to pull its several departments together and to commit themselves to providing adequate facilities to do an interdisciplinary job. The level of effort in any university will probably be in the order of some $1 million a year.

General Betts here in these same hearings under "Materials research," says:

One of ARPA's newest programs in materials research, material deficiencies are a major limited factor in the development and performance of advance systems and devices important to the military as well as to the requirement of other Government agencies, extremely high temperatures, pressures, and vacuums encountered in space and nuclear areas are unyielding obstacles to the advancement of progress. Other factors with which today's materials cannot compete are erosion, corrosion, oxidation, radiation, shock and structural strength, to name only a few. In addition, there is the constant search for materials with improved strength to weight ratio. Much too often today's military equipment failures result because some piece of hardware did not stand up under the rigors of its intended operational environment. * * *

Over 30 interested colleges and universities throughout the country were invited to submit proposals for the basic research program contemplated. With the help of Army, Navy, and Air Force representatives, ARPA has completed a careful screening to select the three best-qualified schools. Contract negotiations will be underway shortly. During the course of our inquiry into how basic research might be increased at the universities, I have found that many graduate schools are already performing some materials research for the Government and are seriously handicapped by the lack of suitable equipment required in this very difficult and complex research effort. On the basis of demonstrated need, ARPA is supporting the procurement of specialized materials research equipment for some 60 universities in the country.

Now, what would be done in the proposed laboratories at Illinois and Notre Dame that cannot be done in the ARPA program insofar as AEC is concerned?

Mr. FLOBERG. We are trying to marshal as much research strength in the materials areas as can be marshaled, Mr. Chairman. It is true in the case of the Commission, as General Betts stated in the case of ARPA, that most of our programs are up against the stops on questions of materials, and it is for the same reasons that he mentioned. We have spent quite a bit of time talking about the nuclear-propelled aircraft today. The technical problems in that case are to try to find materials which will stand up under the heat and radiation conditions and the corrosion conditions that we must face under the extreme conditions that face a reactor of that type.

Now, in specific answer to your question, there just is not enough talent available for quick solution of these problems and we are trying

to make an organized assault on these materials problems in various areas of strength. The Federal Council on Science and Technology coordinates these programs so that the AEC is not going off on a frolic of its own while ARPA is conducting a separate program. All these universities have been discussed within the Federal Council on Science and Technology, and it has been agreed by the participants in the discussion that these are not duplicatory efforts. These are all supplementary efforts and they are in the field of materials, but in many cases the fields of different materials to be used for different purposes, even though the scientific problems are related.

Mr. RABAUT. Why should they not be financed by one program?

Mr. FLOBERG. For the reason that we are talking about different materials for different purposes. In our case, materials that must stand up under irradiation attack as well as other problems. For example, we have ceramics for certain purposes which do not interest ARPA. On the other hand, materials that interest them do not interest us. In the case of Notre Dame, one to which you referred particularly——

Mr. RABAUT. These are very high class colleges we are talking about.

Mr. FLOBERG. Certainly, they are high class colleges. The ones that ARPA selected are high class ones, too. In the case of the Notre Dame facility, this is not a materials laboratory in the sense that the University of Illinois is. This is a radio chemistry laboratory of Notre Dame that would be added to their facilities there. We have an extraordinarily competent group of people headed up by Dr. Burton, acknowledged as one of the few leaders in this field in the world, and giving him facilities with which to have that high caliber group work seems to be a good investment. That is the logic of that investment.

REMOTE SITE REACTORS

Mr. RABAUT. In the opening statement I believe it was said that you would be glad to participate in developing remote site reactors, such as in the Antarctic, if anyone wants to finance them. Would it be in keeping with the usual practice for the using agency to finance any such equipment if they actually want it?

Mr. FLOBERG. Yes, sir; it is in keeping with the usual practice. Actually, it has been a stumbling block to the progress of this program. It has not been the usual practice in this particular case because there has not been any.

General LUEDECKE. We just have not built any of these yet.

Mr. FLOBERG. It is the usual practice in other types of facilities.

Mr. RABAUT. Do you have anybody that wants one?

General LUEDECKE. We believe that the Department of Defense wants these.

Mr. RABAUT. Have they said so?

Mr. FLOBERG. Yes; they testified to the Joint Committee to that effect.

General LUEDECKE. And have said so to us on a cooperative basis.

Mr. RABAUT. Do they want it bad enough to budget for it themselves?

General LUEDECKE. This, we assume, they are considering.

Mr. RABAUT. You mean you have had a little hint from them?

General LUEDECKE. I cannot answer that question specifically as to whether they want it enough to budget for it.

Mr. RABAUT. If the military wants this as an ordinary procedure, they should come around and ask for it.

General LUEDECKE. This was developed before the Joint Committee. The problem that faces the military is that they, like anybody else, have priorities they must establish with their dollars. The question of where this project comes in their priority list determines whether or not they give up something else to finance this.

The plain, simple fact is that up to this point they have not felt that this should supersede anything else they have in their budget.

Mr. RABAUT. In other words, they can't slide it under the ceiling of their budget.

Dr. WILSON. In the long run it would mean a saving in operating cost.

Mr. RABAUT. I know.

Dr. WILSON. The problem is that it would cost less over a period of years because the operating cost of these is lower than the heavy cost of bringing in fuel for the ordinary plant. But then it costs more initially. That is the stumbling block. If it were industry, I don't think they would hesitate to buy this thing, and amortize it rapidly.

Mr. RABAUT. What is the attitude, Mr. Commissioner, of the Budget Bureau on this item?

Mr. FLOBERG. I think you have already stated what the attitude is, and that is they believe that the using agency should finance it.

Mr. RABAUT. Do you have some evidence, correspondence, that we can put in the record on that?

Mr. FLOBERG. Mr. Staat testified to the Joint Committee on this and there is a well developed record before the Joint Committee on this.

Mr. RABAUT. Suppose you supply that for the record. If you have some correspondence on it, we would like to have that.

General LUEDECKE. We have a letter from the Bureau which we can submit.

Mr. RABAUT. All right, fine.

(The letter follows:)

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D.C., March 30, 1960.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
U.S. Senate, Washington, D.C.

MY DEAR MR. CHAIRMAN: This will acknowledge the letter from you and Congressman Holifield on March 15, 1960, concerning construction of power reactors at remote military sites and enclosing letters on this subject to the Secretary of Defense and the Chairman of the Atomic Energy Commission.

We are reviewing with the Department of Defense and the AEC studies of electric power requirements at a number of military sites and the possible economic and logistic advantage of using atomic powerplants at such sites. Results of such studies will be reported to your committee.

For effective management, the responsibility of budgeting for an item should lie with the agency which needs and uses the item. On this basis, we believe that valid power requirements at military sites which can be met to advantage by atomic plants should be funded in full by the Department of Defense. We agree that in deciding whether to build a nuclear or conventionally fuel powerplant at a given military location the operating costs over the useful life of the plant should be weighed as carefully as the capital costs.

The alternative funding approaches cited in your letter to Secretary Gates should not, therefore, apply to the financing of Defense requirements. These alternatives, it is true, have been used or considered in connection with the Commission's cooperative reactor demonstration program, but this program has as its objective the promotion of civilian uses of atomic energy through assistance to non-Federal parties in reactor construction. It would appear unsound and unnecessary to use AEC appropriations in the future to provide similar capital assistance to the Department of Defense in meeting its operating power requirements.

The Department of Defense has already provided the full amount of funds for construction of two nuclear powerplants—one at Fort Greely, Alaska, and a second at Camp Century, Greenland. This approach is also used by the Navy, where construction costs of nuclear-powered ships are higher than those for conventional ships. The same pattern whereby AEC does the research and development and builds developmental prototypes, and Navy funds the full capital costs of nuclear-powered ships, would appear to be appropriate in the case of power reactors at remote military sites.

Moreover, in the future it can be expected that the extensive military and civilian reactor development programs underway in the AEC will act to reduce capital and fuel costs for nuclear powerplants and increase their attractiveness for military situations.

Sincerely yours,

MAURICE H. STANS, *Director.*

CONSTRUCTION PROJECTS NOT OBLIGATED IN YEAR OF AUTHORIZATION

Mr. RABAUT. Please supply for the record the projects budgeted in the last 5 years on which obligations incurred did not occur until after the budget year for which money was requested.

(The information referred to is as follows:)

List of construction projects authorized against which no obligations were incurred in year of authorization

[In thousands]

Project No.	Title	Total estimated cost	Obligations budgeted in year of authorization
	FISCAL YEAR 1955		
	Special nuclear materials program:		
5012	Engineering, facilities for pile charging	$350	$350
5209	Fabrication plant for fuel elements [1]	10,000	10,000
5221	Thorium production plant, Fernald [1]	15,000	15,000
	Weapons program:		
5602	Production facility, Mound Laboratory	5,000	5,000
	Reactor development program:		
5001	MTR operating level revision, NRTS	350	350
	Total, fiscal year 1955	30,700	30,700
	FISCAL YEAR 1956		
	Special nuclear materials program:		
56-d-1	Metallex pilot facility, ORNL [2]	1,000	1,000
56-d-3	Special reactor facilities, equipment [2]	5,600	5,600
56-d-5	Conversion of pilot plant and facility to production plant and facility, Fernald [2]	600	600
56-d-8	Expansion of metal recovery facility, ORNL [2]	370	370
	Weapons program:		
56-f-1	Art construction project, fiscal year 1956 increment [2]	17,873	17,873
56-f-2	Expansion at weapons material fabrication plant and facility [2]	15,000	15,000
56-f-3	New Sigma Laboratory, Los Alamos, N. Mex	4,015	4,015
	Reactor development program:		
56-g-3	Chemistry cave for radioactive material	448	448
56-g-6	Research reactor, Philippine Government	500	500
	Total, fiscal year 1956	45,406	45,406
	FISCAL YEAR 1957		
	Special nuclear materials program:		
57-a-1	Additional feed materials plant [2]	22,200	22,200
57-a-3	Waste handling facilities	5,000	5,000
57-a-6	Charging and discharging facilities	3,450	3,450
57-a-8	Chemical processing plant, St. Louis, Mo. [2]	1,600	1,600
57-a-9	Barrier plant automation, ORGDP [2]	1,400	1,400
57-a-10	Reactor temperature test installation [2]	900	900
57-a-11	Improvements to reactor cooling water effluent system [2]	550	550
57-a-12	Fuel element heat treating plant, Fernald [2]	500	500
	Weapons program:		
57-f-1	Metallurgy laboratory, Livermore, Calif.	2,270	2,270
57-f-6	Manufacturing support plant, Kansas City, Mo. [2]	444	444
57-f-8	Mechanical shop additions, Livermore, Calif. [2]	300	300
	Reactor development program:		
57-c-6	Food irradiation facility [2]	3,000	3,000
57-c-9	MTR hot cell extension	310	310
57-c-10	Power reactor development accelerator project [2]	15,000	15,000
	Physical research program:		
57-d-4	Conversion of accelerator design building, UCRL	300	300
57-h-2	Physics building, BNL	880	880
57-h-3	Engineering building, BNL	1,879	1,879
57-h-4	Engineering services building, UCRL	1,080	1,080
57-h-5	Cosmotron target area, BNL	350	350
	Total, fiscal year 1957	61,413	61,413

See footnotes at end of table.

List of construction projects authorized against which no obligations were incurred in year of authorization—Continued

Project No.	Title	Total estimated cost	Obligations budgeted in year of authorization
	FISCAL YEAR 1958		
	Special nuclear materials program:		
58-b-1	Fabrication plant, MCW [3]	$5,000	$5,000
58-b-3	Metal treatment plant, Fernald [3]	850	850
58-b-5	Additions to scrap plants, NLO [4]	1,500	1,500
58-b-6	Additions to gaseous diffusion plants	6,600	6,600
	Weapons program:		
58-c-2	Weapons special component plant [4]	6,000	6,000
58-d-6	Reclamation foundry, shop and warehouse, Sandia Base, N. Mex.	308	308
	Reactor development program:		
58-e-12	Liquid metal fuel reactor experiment [5]	17,500	2,000
	Community facilities program:		
58-k-3	Additional water wells, Los Alamos, N. Mex.	138	138
	Total, fiscal year 1958	37,896	22,396
	FISCAL YEAR 1959		
	Special nuclear materials program:		
59-a-4	A new waste storage installation, Arco, Idaho	3,200	3,200
	Weapons program:		
59-b-4	Special processing plant, Mound Laboratory, Ohio [4]	2,000	2,000
59-c-8	Lineal acceleration tester, Livermore, Calif. [4]	390	390
59-c-9	Test assembly building	510	510
	Reactor development program:		
59-d-3	Fast reactor safety testing station, NTS	1,367	1,367
	Civilian applications of isotopes and nuclear explosives program, isotopes development:		
59-g-3	Gamma process development irradiator [4]	1,600	1,600
	Total, fiscal year 1959	9,067	9,067

[1] Canceled.
[2] Rescinded in Public Law 85-162, fiscal year 1958 authorization.
[3] Rescinded in Public Law 85-590, fiscal year 1959 authorization.
[4] Proposed for rescission in fiscal year 1961 authorization bill.
[5] Rescinded in Public Law 86-50, fiscal year 1960 authorization.

Mr. RABAUT. Please also insert in the record a tabulation for the last 5 years of the estimated obligations in the budget request for each fiscal year and the actual unobligated balances at the end of the year in the plant acquisition and construction program for each of the last 5 years.

Plant acquisition and construction

[In millions]

Fiscal year	Planned obligations in budget to Congress	Actual unobligated at end of year
1955	$402.1	$755.3
1956	294.7	375.8
1957	306.6	308.0
1958	411.3	222.9
1959	380.4	209.9

SHIPPINGPORT MODIFICATIONS

Mr. RABAUT. Mr. Jensen left a request here for me to ask. The Atomic Industrial Forum memos for March and April report that an AEC ad hoc advisory committee unanimously concluded that a 100-megawatt core for Shippingport would be sufficient to essentially achieve the project's objectives. Why does the AEC plan on going ahead with a larger core at a greater cost and with the additional requirement of $4 million for a steam sink to permit operation at 150-megawatt rate?

Mr. FLOBERG. Mr. Chairman, Dr. Wilson was a member of the ad hoc committee to which you referred. I think he would be the most authoritative person to respond to that question.

Dr. WILSON. That is not a very accurate summary of our report. We said if we were starting anew we thought they could get practically as much information from such a core as from the larger one, and save the cost of the heat sink. On the other hand, it would delay the whole project by about a year and would cost almost as much as the money you would save, and it would not give quite as much information. So having considered those factors we deceided that it was too late to "reverse the field" and ask the Shippingport design group and Admiral Rickover to go back and do the work over again on a smaller core and lose a lot of very important time.

Mr. RABAUT. If you wish to enlarge your remarks on that, you may do so.

Dr. WILSON. Thank you.

Mr. RABAUT. Here is a quote from the ad hoc report:

> We have been assured the engineering work on core 2 at the 150-megawatt rate which has been going on steadily during the past year has already reached such an advanced stage as to render moot the question whether an output lower than 150 megawatts might have been preferable.

Dr. WILSON. That is essentially what I said.

Mr. RABAUT (reading):

> A 6-foot core with a rating of 100 megawatts would be less expensive than an 8-foot core with a 150-megawatt rating. From the review we have been able to make we have not been convinced that the 6-foot core at 100 megawatts would not achieve the essential objectives of the project. Since this is the unanimous judgment of the committee, we feel it ought to be reported.

That is just what you said.

Dr. WILSON. Yes. In other words, if we had been called in more than a year before, we think we could have convinced those in charge of the program that they should design a somewhat smaller core, and it would give most of the information desired, and much more cheaply. On the other hand, it would not give all the information obtainable with the larger core.

Mr. RABAUT. It would not give it all and it has progressed too far.

Dr. WILSON. Yes.

FOOD IRRADIATION PROGRAM

General LUEDECKE. I have a point I want to put on the record if I may with respect to the isotope program and note that this program contains $300,000 for the food irradiation program which is the program on which the Joint Committee recently held hearings.

Mr. BOLAND. Where would this be done?

General LUEDECKE. This particular part of it will be done partly at Brookhaven and partly by contract.

Mr. BOLAND. Isn't the Department of Defense doing work in this area, too?

General LUEDECKE. They are doing a food irradiation program at very high level irradiation. Hearings were held on the two simultaneously.

Mr. BOLAND. Is HEW doing any of this work?

General LUEDECKE. I do not believe there are working on a separate program. They are participating in this program with us but I am not aware of a separate program that they have.

Mr. RABAUT. Any further questions, gentlemen?

COST FACTORS INFLUENCING LOW-COST POWER

Dr. WILSON. You asked for comments that would be of interest. I might elaborate a little on this widespread opinion that the power program has made rather discouragingly slow progress in attaining its objectives.

The early statements with regard to the very low cost of nuclear power were generally made by scientists or people relying on scientists who knew very little about the engineering problems, about the health and safety problems, about the many other things that enter into cost. They just looked at the fact that you can get a large amount of power from a small amount of uranium 235. They did not figure how much it would cost to get the uranium up to a concentration which would make possible fuel elements. They did not have an conception of the very high cost of fabricating suitable and safe fuel elements and making their containment tight under difficult conditions. They did not recognize the need for the elaborate containment methods required for reactors. All the engineers who are familiar with those problems realized the cost of these was much higher than any of the figures proposed by the optimists. But unfortunately the newspapers reported mainly those who would make sensational statements, rather than the engineers and the others who would make more conservative statements.

Mr. RABAUT. Eventually, however, there should be a reduction in price.

Dr. WILSON. There should be and there will.

Mr. RABAUT. For that reason, the Government has its atomic power program for the taxpayers have a tremendous amount of money invested in atomic energy as we realize by calling off these large amounts all day. I don't know how much is in the program now, but some years ago there was $16 billion in it, and I know it is away beyond that now. That is why we like to talk about it occasionally.

Dr. WILSON. That is right. I think looking back we can say if we had gone a little more slowly and cautiously we would have saved considerable money, but there were a great many pressures for doing it as quickly as possible and some overoptimism on what could be accomplished. People that tended to talk about the problem of high cost were accused of playing the power companies' game or being tools of the coal or oil industries.

NUCLEAR-POWERED AIRCRAFT

Mr. RABAUT. Earlier we discussed this nuclear-powered aircraft. It always seemed peculiar to me that when they developed it as far as they did, they did not say, here, for so much money we will put it in the air and show that it can be done, even though it will be slow

Mr. BOLAND. They said they would do it, as I remember the testimony, by the NACA, the forerunner to NASA. They indicated in testimony before that committee maybe 4 or 5 or 6 years ago, that it would be operational in 1961 and they said it would be just a flying platform. I would like to get a look at the size of it when it is up there.

Mr. RABAUT. The point is that it would at least show people, who are not of a technical mind as the geniuses we have before us today, but ordinary rank-and-file fellows like ourselves, that this thing would at least fly.

Dr. WILSON. What about the value demonstrating the flight of a plane that would not have any military value under present conditions?

Mr. RABAUT. All we have now is some more language. It is going to run a little faster than before, but it never ran in the first place.

Dr. WILSON. Conventionally powered aviation has developed so rapidly that the performance objectives set 3 or 4 years previously for ANP to meet, were far surpassed by jet planes.

MISSILE PROGRAM

Mr. BOLAND. I thought I would direct the attention of the committee, Mr. Chairman, to a speech made last night by Gen. John Medaris in New York with reference to the missile program. He specifically mentions, and I presume you would have this information, that the Nation's present reserve of atomic weapons represented the equivalent of 10 tons of TNT for every man, woman, and child on earth. Would you have that information? Is this true?

General LUEDECKE. I will have to do a little bit of calculating to answer it truthfully.

Mr. BOLAND. He is a bit disenchanted with our program anyhow, I would say from reading part of his speech here. I bet he would agree with us on Pluto.

Mr. FLOBERG. I doubt that he would as a matter of fact on Pluto. I think that it might be worth your while to ask him.

Mr. BOLAND. You think Pluto is a good program?

Mr. FLOBERG. It certainly is a unique capability, Mr. Boland.

Mr. BOLAND. That is fine if we have a military requirement for it, if it is a necessary thing. There is no doubt about the fact it is unique. It is completely different.

Mr. RABAUT. Off the record.

(Discussion off the record.)

Mr. BOLAND. I must say we have enjoyed your appearance here. This is one of our favorite commissions. We think you are doing a tremendously wonderful job. I think in your office and in your field you have some of the most dedicated men in the Nation.

Mr. RABAUT. And we are very much impressed with the unity in your commission.

Mr. FLOBERG. We certainly appreciate your sympathetic consideration, Mr. Chairman.

Mr. RABAUT. The hearing is adjourned.

FRIDAY, APRIL 22, 1960.

DETERMINATION OF MILITARY REQUIREMENTS FOR NUCLEAR WEAPONS

WITNESSES

HON. HERBERT B. LOPER, ASSISTANT SECRETARY OF DEFENSE (ATOMIC ENERGY)
COL. PHILIP L. HOOPER
JOHN A. McCONE, CHAIRMAN, ATOMIC ENERGY COMMISSION
A. R. LUEDECKE, GENERAL MANAGER, AEC COMMISSION
DONALD S. BURROWS, CONTROLLER
BRIG. GEN. A. D. STARBIRD, DIRECTOR OF MILITARY APPLICATIONS, AEC
DR. HERBERT YORK, DEPARTMENT OF DEFENSE
JOHN EARLY JACKSON, DEPARTMENT OF DEFENSE

Mr. CANNON. We are glad to have with us this morning General Loper, the Assistant Secretary of Defense for Atomic Energy. General Loper, we have asked you in to give us some information to orient us on testimony that we have previously had, and in preparation for marking up the bill. Would you mind by way of preface giving us a little of your background?

STATEMENT OF ASSISTANT SECRETARY OF DEFENSE FOR ATOMIC ENERGY

General LOPER. Certainly, Mr. Chairman, I am very happy to comply with the committee's request to appear here with information on how requirements for nuclear weapons are established by the Department of Defense and in substance what these requirements are.

I am Assistant to the Secretary of Defense for Atomic Energy, and the chairman of the Military Liaison Committee to the Atomic Energy Commission. I am a retired major general of the U.S. Army, retired in 1953, and have been associated with nuclear weapons work in the Department of Defense since about 1949.

I propose first to make a brief statement to cover the basis for the formulation of weapon requirements, the weapon types that we need, and the weapon systems for which nuclear bombs or warheads are being provided.

Mr. CANNON. That is exactly what we are anxious to hear, Dr. Loper. There has been a wide diversity of opinion on the part of those who have appeared before the committee and those who have briefed the committee. Of course, our objective is to find the latest and the most effective weapons without incurring bankrupting expense. As between those two extremes we would rather succeed in securing more than was required rather than in securing less than will be required. But we do not want to spend any money unnecessarily. So we would much appreciate it if you will let us have your statement as to what is, in your opinion, necessary and essential and something as to the cost of securing it and the time in which it can be made available.

General LOPER. Basically the requirements for nuclear weapons are dictated by the Nation's force structure and equipment of the Armed Forces. As you well know the fundamental mission of the Department of Defense is to deter war and to prevail in war in the event that deterrence should fail. Briefly stated, there are four major elements to this mission.

The first is to prevent the outbreak of general war by maintaining the capability to inflict unacceptable damage on an enemy.

The second is to prevail in general war should that deterrence fail.

The third is to maintain an adequate continental defense.

The fourth is to develop and maintain the capability to wage limited war promptly and successfully using nuclear weapons for that purpose if required.

The structure of the Armed Forces as to manpower, equipment, and organization to perform these major missions is conceived by the Department of Defense, approved by the President and the Congress.

The weapon systems and the numbers of delivery vehicles in these systems having been determined by this combined administrative and legislative process, the determination of the numbers and types of weapons needed for these systems to provide them ammunition becomes somewhat of a mathematical process tempered by the military judgment of the responsible commanders, the Joint Chiefs of Staff, the Secretary of Defense, and finally the President. Because delivery equipment undergoes constant change both as to numbers and types, nuclear weapon needs undergo the same types of change. As new weapons systems are adopted to supplement existing systems, new warheads or bombs for these new systems must be developed or adapted from types already in existence. Also, as older delivery systems are phased out in favor of new developments, there is a necessary overlap in the requirements for weapons, and these overlaps may last for several years.

The situation with respect to improvement of systems for national defense never becomes static. Assuming that the threat to U.S. security continues indefinitely, we see no termination of the need for new types of nuclear weapons.

Now the capability of the Atomic Energy Commission to produce weapons is dependent primarily on the capability to develop new types of weapons which depends on the capacity of the weapon development laboratories. Since it requires a long time to establish a

given nuclear material production capacity, it is necessary that the Department of Defense estimate its weapons needs on a long term basis.

In the interim between these long term estimates which must be on a rather tenuous basis, the Department furnishes the Commission short range estimates of requirements. In the fall of each year the Department submits for Presidential approval and for Atomic Energy Commission guidance a statement of the desired composition for the second year ahead. The Department also furnishes the Commission an estimate of the expected composition of the stockpile for the third year ahead. For example, some time after July 1 this year, the Department will transmit to the President for his approval a statement of desired composition of the stockpile as of July 1, 1962, and if the President so approves the statement will go to the Commission as a production request.

At the same time, for the Commission's further guidance, there will be furnished an estimate of the expected composition of the stockpile as of July 1, 1963.

Now, if I may, I will refer first to the factors which are taken into consideration in the formulation of these requirements and estimates and following that, I will present and discuss the types of weapons in stockpile or under development to enter stockpile within the next several years. The requirements for nuclear weapons originate in the Joint Chiefs of Staff. In defining requirements the Chiefs call upon the commanders of the unified and specified commands, normally about this time of the year, for their statement and views as to their need for nuclear weapons to fulfill the missions which have been assigned to them.

The commanders are fully informed as to the forces which will be available to them, as to any new weapons which will become available and as to any limitations imposed upon them by reason of the availability of materials or other pertinent factors.

When these commanders' estimates are received, they are reviewed by the Joint Chiefs of Staff, adjusted if necessary to fall within the production capabilities of the Atomic Energy Commission for the period ahead, and also to insure a balanced stockpile consistent with the overall security requirements of the United States; and particularly to be consistent with the forces and equipment program for the same period. In the general case the capability of delivering, that is, the strength of the forces they have and the equipment available to them, constitute two of the most important factors in determining requiremens for nuclear weapons.

Now when the Chiefs have adjusted these requirements they submit them to the Secretary of Defense where they are reviewed in a similar manner, particularly to insure that they are consistent with the equipment and with the development and production schedules for delivery equipment and with programed forces as well as the missions of the respective forces.

Now when approved by the Secretary of Defense, the requirements then go to the President and as I have indicated, if he approves, they go to the Commission as a production request.

Mr. CANNON. Gentlemen, after listening to a vast amount of testimony we cannot escape the conclusion that all analyses of our defense problems are colored by ax-grinding between the services, and that the Military Establishment in toto seems to have arrived at a position of tolerance of all theories.

Consequently, we are following what might be called a fluid concept of defense. That is the phrase which has been used before the committee, and specific objectives appear to be lost in semantics.

We would be glad if in the course of your remarks here this morning you would explain in layman's terms, "the finite deterrence"—that is another phrase which has been used before the committee—the finite deterrence of the Navy and the counterforce theory of the Air Force, and these other theories prevalent in the lexicon of the Pentagon at this moment.

General LOPER. I shall try to do that, although I am not expert on these kinds of dissertations. I have no axes to grind, myself, and I do not belong to any service. Now with respect to your inquiry as to the arguments between deterrence and counterforce, this is really not in my field, although unfortunately I have to get in the fringes of it from time to time. The deterrence concept, as I see it, is one held by those who believe that if one maintains a certain destructive capability, regardless of whether it may be directed toward urban populations or otherwise, and the enemy is sure that you have this destructive capability, that is all you need; that you will never need to demonstrate that you have it, in other words.

Now the counterforce people believe that you must be able to prevail in war, not only deter, you must prevail. To prevail is a requirement. To prevail means that you have to deliver something on something. You have to cause that unacceptable damage which you have threatened him with.

Mr. CANNON. I should think, General, that everyone would agree that our first objective is deterrence. We hope we are not preparing to win a war; what we are trying to do is avoid a war. But, of course, everybody realizes that if war comes, we must be in a position to deliver the goods. However, our first objective of course is deterrence, and our eventual objective, contingent upon necessity, to be able to deliver atomic force to the target.

I shall be glad if you will give us in concise terms the hypothesis on which your nuclear military requirements are formulated. How do you determine what shall be prepared for and by the various forces?

General LOPER. It goes back to the basic mission assigned to the Department and the missions assigned to the unified and specified commands. Each one of these forces has a basic mission assigned to it. They are provided certain forces to carry out their mission and in addition certain reserve forces are held in the United States. The commanders of these commands recognizing what their missions are, and the forces which are available to them, submit their requests for nuclear material or rather nuclear weapons just in the same way they would submit requests for any other kind of support. It is ammunition. They have delivery vehicles, they need ammunition

for them. They have, in the case of the Strategic Air Command, for example, definite target lists which are approved, targets which they are required to be able to destroy in the event of war. Now, these factors form the basis for the requests from these major commands.

ALLOCATION OF NUCLEAR WEAPONS AND TARGETS

Mr. CANNON. Does each service require a different schedule or will the same provisions apply to all?

Of course, the question arises there: Are you preparing this weapon for the battlefield; or are you preparing it for cities; or are you preparing it for the destruction of centers of production mobilization or concentrations? I take for granted that is all taken into consideration. Would the same provision apply to the three branches of the service?

General LOPER. In the nuclear weapons business the weapons are not allocated to the branches of the service. The weapons are allocated by the Joint Chiefs of Staff under the authority of the President, with the President's specific approval, as a matter of fact, to the unified and specified commanders for them to further allocate to the forces under their commands as required in the performance of their missions. There is no such thing as a Navy weapon, an Air Force weapon, and an Army weapon. It is a fact that one or the other service has the greatest interest from the standpoint of its delivery equipment and mission.

Mr. CANNON. Now, General Loper, who allocates the target? Of course, we understand the targets of the Navy would necessarily not be targets of the Air Force. Probably the targets of both would differ to some extent from the targets of the Army. Who allocates these targets?

General LOPER. Let us talk about two different kinds of targets. The targets which are to be considered or attacked or destroyed by the strategic force are recommended by the Joint Chiefs of Staff under guidance approved by the President. The targets themselves are actually listed in orders of priority to accomplish a basic task. Then, of course, the Strategic Air Force lays out its plans on that basis.

Now tactical targets, that is, targets which are targets of opportunity or targets necessary to destroy in order that the tactical forces may operate, are selected by the unified or specified commander concerned in order that he may perform his mission. Where there are overlaps between the tactical target selected by the commander and the strategic target, these are adjusted by the Joint Chiefs of Staff.

Mr. CANNON. Of course, there is one thing about nuclear weapons. You never have to strike twice in the same place.

General LOPER. It depends on how big a one it is.

SELECTION OF WEAPONS SYSTEMS

Mr. CANNON. May 9 sums the whole proposition up in one question? If we were forced to cut back if this committee in its wisdom, or its lack of wisdom, decided that we would have to retrench on the number of systems we now have, and on the number we are now developing, which of them would you discontinue?

General LOPER. Mr. Chairman, this would not be my business at all. As I said in the beginning, the decision on what systems are designed, developed, produced, I mean delivery systems, is the business of the Joint Chiefs of Staff, the Secretary of Defense, the President, and the Congress. I am only the man who tries to get the nuclear weapons.

Mr. CANNON. But General, in my opinion, and I think the committee will concur with me in this, there is no one who has a broader or more comprehensive knowledge of this subject than yourself and unquestionably these agencies to which you refer, when they get ready to write these budgets and decide which should be dropped, they certainly will confer with you.

General LOPER. No, I don't think they will.

Mr. CANNON. What is your considered opinion at this time as to which of these systems can be dispensed with to the least disadvantage?

General LOPER. None of them.

Mr. CANNON. You think each one of them is essential?

General LOPER. I daresay there are relative measuring sticks.

Mr. CANNON. There are always degrees of priority and you with your wide knowledge of this subject would unquestionably be called on to advise if it becomes necessary to make reductions, where that reduction should be made. Now without giving us a definite positive answer, just let us have a suggestion as to where it might be made.

General LOPER. In the first place, I would not be called upon to advise as to what the level of the U.S. forces and U.S. equipment in any category would be. That is not my function.

Mr. CANNON. When they call on experts, I think you qualify.

General LOPER. I don't qualify as an expert in the overall security status.

Mr. CANNON. We will not put you in the embarrassing position of saying that they would confer with you, but inevitably your feelings would filter through. Regardless of whether they would or not, will you indicate to this committee now at this time, after having studied this situation in great detail, one or two places in the chart where you think we could best discontinue production with the least disadvantage to our system of national defense?

General LOPER. In considering any cutback in warhead production or any system production I think one has to take the status at present and see where you stand with respect to the development and adoption of any given system, and then see how much you gain or lose by abandoning the development of that system. In other words, I do not think this is a question that can be answered categorically. I think I can only go back to the basis which assigns certain functions for the Department of Defense to do. Now how much equipment, how much effort, what forces it takes to do those things is a matter of judgment in which I do not participate.

Mr. CANNON. Then, General, there is another classification. We have been considering those which would be delivered in open warfare, and which have as their target definite military objectives. How about delivery surreptitiously in other forms and in other places, brought in as luggage or brought in in the form of merchandise and placed at strategic points?

General LOPER. That is a problem which has been very thoroughly considered, or certainly extensively considered. I presume you are

speaking of the possibility that some such weapon might be brought surreptitiously into the United States or that we on the other hand might surreptitiously bring such weapons into an enemy's country. Certainly very thorough consideration has been given to the possibility, and I think it is recognized that there is a possibility of something of this sort happening.

Mr. CANNON. Incidentally, General, despite your modest protestations of not being consulted, you have just told us that recently you had consultation with the Joint Chiefs of Staff and you gave them the benefit of certain information you had.

General LOPER. But the benefit I gave them was not how many wings or squadrons of B–52's they should have. They did not ask me about that, Mr. Chairman.

Mr. CANNON. We are considering only two things, General. We are considering weapons and we are especially considering the manufacture of materials with which to provide the warhead for these weapons. Now that being true, do you think we can at this time begin to cut down?

General LOPER. Not on production; no, sir.

Mr. CANNON. Of the material for warheads?

General LOPER. No, sir.

Mr. CANNON. General, before you close your statement, and we very much appreciate your meeting with us, have you any other suggestions which you consider pertinent affecting this situation?

General LOPER. I don't believe I have, sir.

TRANSITION TO MISSILES

Mr. RILEY. General, did I understand that as you go from bombs which are carried by planes to missiles that it is absolutely necessary to get lighter and easier to handle warheads?

General LOPER. Yes, sir.

Mr. RILEY. That is the advantage or the objective in reducing the size of your warhead in order to complete this transition, if we are to complete it, from planes carrying missiles to ballistic missiles.

General LOPER. That is right. The effort required to handle them, to move them, to provide logistics support, decreases a great deal with the size and of course the cost of the propulsion system decreases.

Mr. RILEY. Is it not reasonable to suppose that the Soviets are having the same difficulty in refining and reducing their warheads to fit their missiles as we are having?

General LOPER. I would assume that they are having the same experience. We don't call this necessarily a difficulty, but it is a fact of life.

Mr. RILEY. It takes time. You can't do these things overnight.

General LOPER. That is right.

Mr. RILEY. I was tremendously impressed about a year ago in seeing some of the Soviet exhibitions at the fair in New York. Most of their machinery was cumbersome and heavy. Reasoning from that standpoint, I would think that some of their missiles are in the same category.

Now I have one other question. Is it reasonable to suppose that General Medaris, being an Army man, referred more to the need for

tactical weapons as against heavier and more strategic long-range missiles? Do you think that perhaps was inculcated in his remarks?

General LOPER. I don't really know. I don't know the gentleman.

Mr. RILEY. I don't either. But I would be inclined to think that that had something to do with his statement. Frankly, from my own standpoint, I never expect to see the big bomber go out during my lifetime. Personally I think it is absolutely essential that we keep it. It is the most accurate thing that we have and I believe that it is going to continue to be the most accurate weapon that we have in our deterrent program.

Now I think you can mix it with missiles, but these missiles are not as accurate as I would like to see them, and we have a great many failures and I think it will continue to be that way for some time to come. I think the people across the ocean are having the same experience. They don't tell us about their failures, but I think they have had a few. Thank you.

Mr. CANNON. Mr. Boland.

Mr. BOLAND. General, one of the statements you made here indicated that it takes a few years to develop a system and a few years to develop a warhead. Would it not be well to wait until the system is developed before we develop the warhead?

General LOPER. Well, at some time during development of the system the decision needs to be made as to what the exact characteristics of this warhead must be. This normally comes at a period during the development of a system. Here I am speaking primarily of the missile systems because for bombers, one does not normally have to be so rigid in your characteristics because they do normally accommodate themselves to different sizes and weights of bombs. But at a particular point during the development of the system one has to then decide upon the characteristics of the bomb and warhead and then start its development so that the two come out operational at the same time.

BOMARC

Mr. BOLAND. The next question is a little outside the sphere of this particular committee, but within the full committee, of course, and it has reference to the BOMARC. What is the status of it? This is a particular system or weapon that is giving the Congress a considerable amount of interest and giving the Nation a considerable amount of interest, also. What ought we to do with it?

Let me also ask you whether or not political considerations, I don't mean party considerations, I mean influences which come because Communists may suffer from a loss, from the development of a particular weapon—does this have any influence in the whole decision with reference to BOMARC and can we do away with BOMARC without injuring our national defense posture?

General LOPER. This again is outside my area of competence. I, like you, would like to know what a final decision on BOMARC may be. But what we lose or what we gain by doing it and what the local affairs involved in this may be are beyond my area of competence.

PLUTO

Mr. BOLAND. Now, with reference to one that is within this committee's sphere, and that has to do with Project PLUTO, which as

you know is a ramjet nuclear propelled missile. There has been considerable, or there is considerable, split of opinion concerning it. There were some physicists who did not look upon it with any particular degree of enthusiasm.

General LUEDECKE. I think that is about correct, sir.

Mr. CANNON. Proceed.

General LOPER. I can only have a personal opinion and that is that the system looks attractive from the standpoint of the many things it could do if it can be made to work. I believe, however, that your committee is to hear some views from our Director of Research and Engineering this morning, and I would prefer to pass on this question.

Mr. BOLAND. Do you know whether or not there has been any decision by the Joint Chiefs of Staff, and whether or not there is a military requirement for this particular weapon?

General LOPER. No, there has not been such a decision so far as I know that there is a military requirement for this system. It is being examined from the standpoint of its technical feasibility only.

Mr. CANNON. Dr. York is here, the Director of Military Research and Development May I ask your indulgence, gentlemen.

Dr. York, will you come to the table?

Mr. JENSEN. I want to say this, Mr. Chairman, to the general, I appreciate very much his coming before the committee and he has proved to me and I am sure to every member of the committee that he is very capable of performing the duties which have been assigned to him. It is good to know men like you come back into the service of his country and perform such valuable services.

I want to say that I appreciate your appearing before the committee.

Mr. CANNON. General Loper will remain with us.

Mr. JENSEN. I know, but I wanted to say that——

Mr. CANNON. Dr. York, will you favor us by giving us some of your background?

STATEMENT OF DIRECTOR OF MILITARY RESEARCH AND DEVELOPMENT, DEPARTMENT OF DEFENSE

Dr. YORK. I am at the present time Director of Defense Research and Engineering. Prior to that I was chief scientist for the Advance Research Projects Agency. Prior to doing that, I was director of the Livermore Laboratory in California, now the Lawrence Laboratory.

Mr. CANNON. Mr. Boland.

NUCLEAR-PROPELLED AIRCRAFT

Mr. BOLAND. I am sure you will probably develop this a lot better. I unfortunately have to leave this afternoon. One of the reasons why General Loper is before the committee, and yourself, Dr. York, and I think all of us join in what the gentleman from Iowa has said in reference to our gratitude for your appearance here is to discuss the ANP. We are happy in the fact that you are in the Government service and doing the magnificent job both of you are doing, but we do have some concern over the airplane propulsion reactor program of the AEC. I think this is a concern that is shared by a lot of people, both in the program and outside the program. As has been pointed out here in testimony by the AEC and developed by members of this

committee, we have spent over a billion dollars on the program. We are going to spend another billion more and it may be another $3 billion. No one knows how much we will spend on this program because no one knows of the problems you will encounter in the research and development effort.

I think the first question we ought to start out with is with reference to the PLUTO program. Have the Joint Chiefs of Staff indicated any military requirement for this program or for an A plane?

Dr. York. The Chiefs concluded that there is a considerable military potential in nuclear powered aircraft which make the achievement of this capability in the national interest, that they could not at that time make a precise statement as to the precise military application for such an airplane or to define at that time a specific weapon system that would use a nuclear airplane. They went on to say that they believed it was militarily desirable, however, to undertake a flight test program as soon as a flight test program should be considered technically feasible and that it should be capable of testing any of the various kinds of engines and so on that we have under development.

In other words, what they are saying is that nuclear powered aircraft are—the possibility of nuclear powered flight would represent a breakthrough in one of the several factors that people are always, one of the several directions that people are always trying to improve airplanes in. That is, we are always trying to get airplanes that fly higher, faster, with greater payloads, for greater distances and greater duration. Nuclear propulsion bears on the latter two. If it works out it gives us a potential for longer duration and longer distance flight. The Chiefs regard that as being a very important thing to achieve. It does not help with regard to the other parameters.

Mr. Boland. Do you share this opinion, too?

Dr. York. Yes.

Mr. Boland. It is difficult for me and I am sure it is difficult for other members of this committee here to recognize any particular military advantage in this kind of plane. It does not seem to have any military advantage.

Dr. York. Well, nuclear-powered flight has the advantage that it can fly further and can fly for a longer time.

Mr. Boland. We wonder whether or not this is worth the effort. You are probably familiar with Admiral Rickover's testimony about that.

Dr. York. I have talked to him about it.

Mr. Boland. He did say, and I think all of us agree, and the record shows that this is a long time in being and probably will be a long time more before it is actually put in flight. He said it would be extremely costly and the question that must be resolved and must be resolved by this committee and the Congress is whether or not the huge expenditure of money is worth it. The chairman the other day indicated that in the initial appropriation for the Atomic Energy Commission for the Manhattan Project it was $2 billion. We are now with just one phase, one particular program in the AEC; it is costing that much now, and a lot more probably. What is your opinion on what the cost might be?

COST OF ACHIEVING NUCLEAR FLIGHT

Dr. YORK. In order to achieve nuclear flight of the sort we are now aiming for, it is the better part of a billion dollars. It might be somewhat less, but it is the better part of a billion dollars. To achieve a useful weapon system that involves a number of aircraft and all that goes with it, it would be several billion dollars, or many billions. That is true, though, of any major system. They are all costing many billions, whether it is ATLAS, POLARIS, B–52.

Mr. TABER. Will the gentleman yield?

Mr. BOLAND. Yes.

Mr. TABER. At this particular point how can any of you tell what the carrying on of that sort of thing will be? After you get the first one, you are just as apt as not to run into different methods of handling the thing, and you really can't tell much about what the ultimate cost might be.

Dr. YORK. No, but you can tell that it won't be less than several billion dollars.

Mr. TABER. I have seen some things where it worked out to cost less than the folks figured.

TECHNICAL PROBLEMS

Mr. BOLAND. There are certain fundamentals from which you cannot get away, are there not, with reference to the development of this kind of aircraft, particularly shielding? Now, we have to depend on the knowledge and ability of physicists and scientists and you are one of the most distinguished in the Nation and so recognized, now, have we advanced one iota, would you say, with reference to the problem of shielding? We are conducting a lot of tests out there. I have seen the site and I have seen the installation. Have we actually advanced very much with reference to cutting down the size of the shield and the effectiveness of a particular shield?

Dr. YORK. There has been advance in the field; yes.

We have under development the two types of systems, the direct air cycle and the indirect air cycle. The indirect cycle is the one that has the smaller reactor and therefore the smaller and lighter shield. That is therefore the reason that many of us think that is the system with the most long range potential. On the other hand it is in some ways the least advanced and the most difficult from the point of view of the plumbing job that has to be done.

Mr. BOLAND. Do you see the possibility of the development of an A plane that will be as fast moving a plane and a relatively small one compared to the concept that we have been shown, or the particular diagrams or pictures or even with reference to the size of what Russia said they flew?

Dr. YORK. I don't think you can go very far in those two directions simultaneously, but there certainly is a potential of going faster, and there is also a potential of going lighter, but not both at the same time. One can get lighter aircraft—now that is lighter than the model 54 aircraft—that is still not a small airplane. You can get lighter aircraft by going to turbofan and turbojet operation, but then you would be stuck subsonic. With some of the systems that we

think may follow on from the present plan, we do see the potential of supersonic flight.

ADVANTAGES OF ANP

Mr. BOLAND. Now, with the program that is envisaged and also in being, the missile program plus the satellite program, what really is the advantage or the requirement for a long-distance-flying airplane? What good would it do, with the tremendous development that we have in missiles and in satellites? Why do we need it?

Dr. YORK. I don't think satellites have an awful lot to do with it. There is a competition between missiles and aircraft. This competition for bombardment purposes. Of course, that is not the only thing that aircraft are used for. Aircraft are used today, and I am sure will continue to be used 10 or 20 years from now, for all sorts of transportation purposes, and for surveillance, reconnaissance, and so on.

Now, in the bombardment area, the question of competition between missiles and aircraft is one which is primarily, which has to be primarily studied by the military people, rather than by the development people. In their judgment, there are reasons and there will continue to be reasons for wanting aircraft in the bombardment role. As I say, that is primarily the responsibility of the military people, of the Chiefs, to come to conclusions like that. I know that they have in mind such things as the fact that aircraft are recallable whereas missiles are not; the fact that they are recallable means that you can change your mind and that, carrying on one step further, means that you can afford to launch aircraft on lesser warning than you can afford to launch missiles. You cannot afford to launch missiles until you are absolutely sure. Aircraft can be launched, started on their way with considerably less warning, because they can always be called back. Aircraft have the capability of hunting out targets. To the extent that that is possible or to the extent that that would be needed in a future war, I really cannot say, but at least aircraft with men on board can do a certain amount of what can be called armed reconnaissance. They can be looking for targets rather than simply preset and fired.

Then can carry larger payloads. They will probably always be able to carry larger payloads, at least for vehicles of comparable cost. This came out in much of General Loper's testimony I heard earlier. In practice and in principle they can probably be built so that they have a higher degree of accuracy. That makes it sound as though we ought to have aircraft instead of missiles.

The other side of the story of course is that the missile is quicker and the missile has probably a much higher certainty of penetration.

INVULNERABILITY OF ANP

Mr. BOLAND. Do you see the probability of its being rendered invulnerable to attack? The A plane?

Dr. YORK. Invulnerable to being intercepted?

Mr. BOLAND. Attacked or destroyed in the air.

Dr. YORK. But invulnerable to defense?

Mr. BOLAND. Yes.

Dr. YORK. No, it is vulnerable. Any aircraft is vulnerable. It is a question of degree rather than absolutes. It has some advantages

over other aircraft with regard to invulnerability and some disadvantages. Because of the nature of the powerplant the infinite range compared with chemical fuels, it can fly for greater distances at low altitude. In principle it can fly greater distances at low altitude. Low altitude flying is a means of decreasing vulnerability. But you could not say it would become invulnerable.

Mr. BOLAND. The Russians had a release on it a year or year and a half ago, and they had a picture in the paper of the huge plane they had flown.

Dr. YORK. I don't believe the Soviets released information that said this is our atomic airplane. There were pictures of a hypothetical aircraft in some of the——

Mr. BOLAND. It came out of the magazine and the newspapers reproduced it.

Dr. YORK. Yes, but I believe it was an American magazine.

Mr. BOLAND. That is true, it was. Do you think we ought to continue this program at the particular cost that is involved and the problems that are current in it?

Dr. YORK. I think this level is about right in order to have a development program which is consistent with the guidance of the Joint Chiefs of Staff with regard to the desirability of this kind of airplane.

Mr. BOLAND. Thank you very much, Doctor.

That is all, Mr. Chairman.

Mr. CANNON. Thank you, Mr. York. Will you be seated, please? General Loper, Mr. Jensen. Mr. Taber.

ADEQUACY OF NUCLEAR WEAPONS INVENTORY

Mr. TABER. General, has the armed services been supplied with as much as the warheads as the different types of atomic items as they really need at this point?

General LOPER. Mr. Taber, I can only say that we have not had to use them and therefore we don't know exactly how many we really need.

Mr. TABER. Is there anything on foot at the present time?

General LOPER. Yes, this buildup in numbers which I have showed you is designed to just accomplish that, to provide a minimum of at least a single load for every aircraft on the line which has a competency.

Mr. TABER. I think that is all I have.

Mr. CANNON. Mr. Pillion.

AEC WORK RELATED TO DEFENSE

Mr. PILLION. General, I note in the justifications here the total budget of the Atomic Energy Commission for this year is about $2,464 million, of which roughly we have $630 million for raw materials, $567 million for special nuclear materials, and $504 million for weapons. I assume that all those items directly contribute to the defense effort?

While we are following that, I note a number of items for reactor development, physical research, biology and medicine, training and

education, civilian applications of isotopes, community programs, program direction and administration, security investigations, other costs, adjustments, and so forth, which may amount to about $800 million. How much of that is directly related to the defense effort?

General LOPER. I think this will have to be answered by the Commission as to how these things are proportioned as between applications to military requirements and to the civilian functions of the Commission.

Mr. PILLION. Is there anything in the isotope study that has a direct relationship to our defense program and the nuclear capability of this country?

General LOPER. Well, there are certainly things in the study and work which are of military value because——

Mr. PILLION. I am talking about direct military value as of today, tomorrow, or the next day.

Dr. YORK. Probably not.

Mr. FLOBERG. I would think not.

Mr. PILLION. Now, the examination into the makeup of matter, energy, the Einstein theory, the universe, whether it was created 5 billion years ago or 10 billion years ago, is that of any value to you as a military expert in defending this country today or tomorrow or 5 years from now?

Dr. YORK. I would say not. However, it may lead——

Mr. PILLION. That is right, but as of knowledge now, it is a sort of theoretical and civilian addition to our total sum of knowledge. But it was given yesterday as one of the basic reasons why we should continue this nuclear plane development. Do you agree with that?

Dr. YORK. I don't offhand see any connection.

Mr. PILLION. In other words, I am trying to create a line of demarcation between how much of these funds are urgently needed for defense and how much is a matter of academic and theoretical study. I can't find the line of demarcation. They overlap one over the other. As soon as you start talking about research, immediately it has some military application. I want to know where the mark is between a direct military application and just a lot of professors studying. I don't like to see hundreds of millions of dollars spent with the label of urgency when it is not an urgent situation. It is just a matter of adding to our knowledge that perhaps someone may use. I don't like to have the military put their label on it that they need it when there is no direct foreseeable need for this situation. The flow of money, our work, our energy, our engineering, we have to pace that so that we get a maximum defense, but not more money for something that is not necessary or urgent. I just can't seem to find that line of demarcation as to what is defense need and what is an academic or theoretical study. That is not in a form of a question.

General LOPER. Of course, we recognize that a study of basic physics was necessary to get where we are. We don't know what it may mean in the future except it may mean a military advantage to us. Where one can draw a line between that which will and that which will not is beyond my comprehension.

NEED FOR NUCLEAR POWERED AIRCRAFT

Mr. PILLION. Well, let us look into that. Any military objective for a nuclear airplane would have a maximum distance of maybe 10,000 or 12,000 miles; is that about right?

Dr. YORK. One way there is no place that is farther than 12,500 miles.

Mr. PILLION. Why do you need a plane that will be up in the air for 150,000 miles?

Dr. YORK. For bombardment purposes you may not need one. There are concepts that would involve an airplane being up—it is not so much the miles but it is the time so that it can be on station for a long period of time.

Mr. PILLION. That is right.

Dr. YORK. On the other hand, this is something which in the past has always been sought. In all of our airplane programs, we have always tried to get the range out and the endurance up.

Mr. PILLION. A few years ago the military slowed up this program considerably, did they not?

Dr. YORK. I think there was more money and then there was a period when there was less.

Mr. PILLION. What change of conditions has there been since that time that now require a speedup?

Dr. YORK. We are not speeding it up.

Mr. PILLION. That require the present level of expenditures?

Dr. YORK. We are continuing the program that we set last summer. We oriented the program to about this level, which is approximately $150 million a year between the two agencies. Nothing has happened to change that in either direction, in my opinion.

RUNWAY FOR ANP

Mr. PILLION. Two years ago we had some hearings in which there was some colloquy between Mr. Budge and Mr. Floberg, I think. At that time, the gist of this was that the Defense Department had requested funds 4 years prior to that time for this plane. They purchased an awful lot of land for the runway for this same plane. This was hearings 2 years ago and request was made 4 years prior to that. So what sort of synchronization of our work and spending do we have in this program?

Dr. YORK. I can't speak of 6 years ago.

Mr. PILLION. Looking at this record, I am amazed.

Dr. YORK. That is what the consensus last summer was when we reoriented the program to its present shape.

Mr. PILLION. It has been reoriented a number of times and we seem to be no further ahead.

Dr. YORK. We are further ahead. However, our predictions are very nearly the same as they were then, but we are further ahead.

Mr. PILLION. And the goal is still a very shimmering, indefinite, and intangible one as far as the utility of this plane is concerned.

Dr. YORK. As far as the precise utility.

Mr. BOLAND. What were you saying with reference to runways?

Mr. PILLION. I was saying in an exchange here between Mr. Budge and Mr. Floberg, Mr. Budge made reference to the fact that that De-

fense Department had requested funds for a runway for this plane and the purchase of land, I guess thousands of acres of land, for a runway, 4 years previous to this colloquy which took place 2 years ago.

Mr. BOLAND. Did they actually purchase the land?

General LUEDECKE. The Air Force requested authorization for the facility which would include the land.

Mr. BOLAND. There was no specific request with reference to Stapleton Field out in Denver, Colo., was there?

General LUEDECKE. So far as I know from the AEC side, there was not. But that would have to be checked specifically with the Air Force.

Mr. BOLAND. The only reason I asked the question is that a couple of years ago I was at the Air Force Academy, there was some editorial in the Denver Post, I think it was, indicating that they were going to build this long runway for the purpose of taking care of the A plane. It was completely new to me. Was there any basis to it?

Dr. YORK. It sounds like speculation to me.

Mr. PILLION. As I understand the situation the funds were appropriated but they were not used essentially. Is that a correct statement?

General STARBIRD. That is my understanding.

MILITARY REQUIREMENT FOR ANP

Mr. PILLION. From the testimony here, and this has perturbed the committee at no end, since there is no definite military requirement for this. Would you not say, Dr. York, this is more in the field, this whole program for this atomic propelled plane is more in the field of civilian use rather than a needed urgent defense situation?

Dr. YORK. No, I would say—incidentally, I am sure it does contribute, the development of these high temperature reactors may be useful in all sorts of ways, but this program is probably best characterized as an exploratory development program designed to explore an entirely new means of flight which in turn has potential which the military regards as very important.

Mr. PILLION. Essentially there is no military requirement for it. It is a space flight. It is a civilian situation rather than an urgent known military requirement.

Dr. YORK. No, there is no specific military requirement for a nuclear bomber with such and such characteristics at such and such time. There is and always has been a military requirement for flight for longer distances and for greater endurance. In other words, it is a qualitative requirement rather than a quantitative requirement, but just as real.

Mr. PILLION. But very unspecific.

Dr. YORK. It is not specific.

PRIORITY POSITION FOR ANP

Mr. BOLAND. May I just ask this question? In all of the programs in which you are engaged, and they are multitudinous, and again I say I think you are doing a good job, where does this program stand in priority, Doctor?

Dr. YORK. Not at the top.

Mr. BOLAND. It is very far down?

Dr. YORK. I don't know, except not at the very top.

Mr. BOLAND. You are really disenchanted with it a little bit?

Dr. YORK. I think we all wish that it was much further along, and it was doing better than it now is.

Mr. BOLAND. You do then see the possibility of its doing better than it is?

Dr. YORK. Yes.

Mr. BOLAND. That is all. Thank you.

INTERRUPTION IN PRODUCTION OF NUCLEAR MATERIALS

Mr. RABAUT. Doctor, the military is supposed to contemplate all kinds of emergencies. You say you must have a plan in case a Hanford reactor burns down. Tell us about these plans.

Dr. YORK. I think those plans are worked out in the Atomic Energy Commission, Mr. Rabaut.

General LUEDECKE. You mean a plan for handling the emergency that would be created?

Mr. RABAUT. How about General Loper?

General LOPER. I think this is a problem for the Commission if they have an accident or trouble in a reactor.

Mr. RABAUT. Would you have to do something about weapons?

General LOPER. If one of them were to be destroyed, their capacity for production of course would go down and we would have to adjust our requirements until it could be recovered.

Mr. RABAUT. Is there any kind of plan? It is an emergency that could happen.

General LOPER. I don't know what we can do in the way of planning for it. You either get the materials or you don't. If a reactor is destroyed and you don't get the materials, you can't get them through a plan except by rebuilding a reactor.

Mr. RABAUT. So we would be stymied, partially?

Mr. CANNON. Mr. Jensen.

Mr. JENSEN. I passed before. May I ask some questions?

Mr. CANNON. Yes.

VALUE OF ANP

Mr. JENSEN. I am sure, Doctor and General, you have come to a conclusion long before now that the committee is quite skeptical as to the value of this proposed nuclear-propelled aircraft. Now, I am beginning to be quite skeptical of it, to say the least. My question is, What would be the position of the Atomic Energy Commission and you, Dr. York, should the committee feel constrained after going through all these hearings, to eliminate the item for this proposed plane?

Dr. YORK. What would be my position?

Mr. JENSEN. Yes.

Dr. YORK. That the committee had made a mistake.

Mr. JENSEN. You think it would be a bad mistake?

Dr. YORK. I think it would be a mistake. I don't know what qualifiers to put in front. But our position is that it is right to go ahead.

Mr. JENSEN. I assumed that. But we are groping, it seems, and that groping may come to naught after we have spent several billions of dollars that we do not have in fact to spend on something that is so uncertain as a nuclear-propelled airplane proposition. You understand that this committee is in a very precarious position. You would agree that if we go along with this thing we are appropriating a lot of money, almost in complete darkness.

So as representatives of the people we are up against it. Of course, I would not like to have it on my conscience to be a party to the stopping of the construction of such a plane and then find that the Russians had beaten us to the finish line in this respect. Of course, I liken this proposition to the atomic-powered submarine a few years ago before we appropriated the money for the first one. We took one man's word for it and we appropriated money, and we were so right. I hope that the same result will be accomplished here with the A-powered plane but it is going to take a lot of research, a lot of study, a lot of experiments. I concede that. And it will take a lot of money. You are going to have to try, fail, try and fail again before the bugs are all taken out of it. That is going to cost a pile of money. How many people are working on this proposition?

Dr. YORK. I don't know the number.

General LUEDECKE. About 6,000.

Mr. JENSEN. How many of them are nuclear scientists, construction engineers, airplane construction engineers? Do you have the best in the country working on this thing?

General LUEDECKE. I don't think the best in the country. I think we have competence in both contractors. The actual breakdown of qualifications I will have to get for you.

Mr. JENSEN. That is all, Mr. Chairman.

Mr. CANNON. Dr. York, as has been said, the problem of the committee is whether or not having already spent approximately a billion dollars on the atomic airplane, with the immediate prospect of spending another billion dollars to secure a plane with a maximum speed which is relatively a sitting duck, and which will remain aloft and be manned by replaced crews, each of which must be decontaminated before coming down; whether or not this money could be better spent in something of more immediate prospect. By the time this plane is developed everything we now have will be obsolete. The problem is then whether or not we should spend this additional billion dollars for this purpose at this time. As Mr. Jensen has said, these 6,000 men you are employing—men who cannot be recruited on demand, men of special training and special capacity—whether or not we should devote their time, attention, and knowledge and these technical facilities to something productive of more immediate results.

Dr. YORK. That of course is also a question that the Air Force, the Atomic Energy Commission, and the Department of Defense have faced and have concluded that we should do to the program we submitted to the Congress.

Mr. CANNON. You know Karl Marx promised as part of his program, which we seem to be following pretty accurately, that we would spend ourselves into economic chaos, a situation just as deadly as a Russian A-bomb, and unless we husband our resources more effectively than we have in the past that situation may very well come about. In

other words, this committee is right now at the crux where we must make some hardheaded decisions. What is your recommendation?

Dr. YORK. My recommendation is that we go ahead with this program, Mr. Cannon.

Mr. CANNON. Mr. Rabaut.

Mr. RABAUT. No questions.

Mr. CANNON. Mr. Jensen.

Mr. JENSEN. No questions.

Mr. CANNON. Mr. Taber.

Mr. TABER. No questions.

Mr. CANNON. Mr. Pillion.

Mr. PILLION. No questions.

Mr. CANNON. We have four questions here which I will turn over to the reporter to be delivered to you with your transcript. We shall be glad if when your transcript comes to you you will feel free to extend it, include any elaboration that occurs to you, and also give us an answer on these four questions.

General LOPER. Yes, sir.

(The answers were furnished to the committee.)

Mr. CANNON. General Loper and Dr. York, we deeply appreciate your attendance here this morning and the information, counsel, and advice you have given us. We feel that the country is a little bit safer with men of your caliber and training available than it would be otherwise. Thank you.

The committee stands adjourned.

SPECIAL SUBCOMMITTEE ON NUCLEAR PROPELLED AIRCRAFT

GEORGE H. MAHON, *Chairman*

HARRY R. SHEPPARD, California
LOUIS C. RABAUT, Michigan
BEN F. JENSEN, Iowa
JOHN R. PILLION, New York

WEDNESDAY, MAY 11, 1960.

NUCLEAR PROPELLED AIRCRAFT PROGRAM

WITNESSES

HON. THOMAS S. GATES, SECRETARY OF DEFENSE
DR. HERBERT F. YORK, DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING

Mr. MAHON. As you know, Mr. Secretary, there is about $75 million in the President's budget under the Air Force appropriation for research and development on the proposed nuclear powered aircraft and there is something around $73 million under the atomic energy program.

The $75 million request has been handled by the Subcommittee on Defense Appropriations and the full amount approved by the committee and the House.

I should point out that what we should do about the request which comes through the AEC, is to be determined by a subcommittee handled by Mr. Cannon.

Of course the findings of that subcommittee will be presented to the full Committee on Appropriations for consideration.

In the presentation before the full committee of the defense appropriation bill an amendment was made to strike out the $75 million for the atomic airplane, which was carried in the defense bill.

This motion was tabled. There are very strong views on both sides of the issue. Generally speaking, there is considerable skepticism as to the feasibility of and the military necessity for the nuclear powered aircraft. We all realize that this is to some extent an emotional issue, that the prestige of the United States is involved and that people were jumping up and down a few months ago saying, "Get an atomic airplane flying. Let's don't lose the prestige race," and people have complained on both sides, "You are not going fast enough," and "You are going too fast," or "You are trying to achieve the unattainable," or "Even if you attain your objectives they won't be worth attaining because there will be no great value that will be derived."

A wide variety of allegations have been made on various sides of this issue.

A special subcommittee was appointed by Mr. Cannon a short time ago to look into this matter and determine what should properly be the attitude of the Appropriations Committee on this subject. Of course, the committee will have to do considerable work and study before it can make a mature decision as a subcommittee.

A motion was made in the full Committee on Appropriations, and in connection with that motion it was stated, and the motion contained something of this kind:

> The committee is not satisfied that the present project is of military value, or that progress made is as substantial as it should be.
>
> The committee therefore urges a thorough review of the project, both as to its value, if completed, and the rate of progress, if the project is redetermined to be essential to the overall well-being of the Nation.

About 4:15 yesterday afternoon I called you and asked you to appear before this subcommittee this morning. You were kind enough to agree to come but you pointed out that you were leaving for Europe in connection with the summit conference on Thursday and that your commitments were such that you would have difficulty preparing to make a suitable presentation to this subcommittee. That was certainly understandable.

You are here this morning and we appreciate it. We understand your difficulties in presenting to us your opinion on a highly technical subject on such short notice. We have been told that the program for the nuclear powered plane was redirected a few months ago. We understand that an effort is being made to develop a feasible powerplant for the plane and that two special approaches are being considered. One is the so-called direct cycle engine and the other is the indirect cycle.

The indirect cycle seems to have more favor, according to the testimony which has been presented to various committees.

POSITION OF DEPARTMENT OF DEFENSE

I think what we want is your judgment as to what to do. Do you favor the program as presented in the budget estimate? That is one of the questions I want you to answer "Yes" or "No" to if you can, and then elaborate on all you want to. More or less, you are on the spot, I assume, because you are supposed to favor the budget estimates, but if something has happened since the budget estimate was presented that causes you to weaken in this position, I hope you will

be utterly frank with us. Do you favor a modification of the program at this time and if so, what modification do you favor?

In other words, would you be willing to say that you would suggest we cut off funds for use of these approaches to this problem?

In your opinion, if the House should eliminate funds for the least promising approach to the development of the powerplant, would the Department of Defense accept this as a wise decision or would the Department seek restoration of the funds in the other body?

Let us assume that Congress appropriates a full budget estimate for the nuclear powered aircraft. Would you be able to give the committee definite assurance at this time that within a maximum of about 4 months from this date you could modify the program by eliminating either the Pratt & Whitney or the General Electric operation, which is requiring the services as I understand it, of something in excess of 7,000 employees.

That is the background. I talked a long time. You do not need to talk this long if you will tell us what you think.

Secretary GATES. Mr. Chairman, you have outlined the important pieces of the difficulty. Last summer this program was reoriented into a research effort. There was great pressure at that time on the part of a great many people to fly an airplane and the Department of Defense resisted this pressure, feeling that the important thing to do was to put this back in a research effort on learning about the components that were required, many of them new and untried, for a proper reactor so we reoriented the program back and testified in open hearings before the Joint Committee on Atomic Energy to this effect and this is the program we are undergoing now. It has been a year since the last review. We are setting up another review now to analyze the question and under the Assistant Secretary of the Air Force Perkins for Research and Development.

This review may choose between these two approaches or it may continue both of them. We are not ready quite yet to know what we will do. We have great possibilities of getting out of this important reactor development, which Dr. York can discuss better than I can. It involves high temperature and high power density where you get compact and efficient reactors.

We have set the same goal for each approach, which did not exist last year, namely, an airplane that will fly up to 35,000 feet at mach. 8 and have a thousand hour life of the reactor, so each approach is going toward the same goal.

There is an increased effort being put on the indirect cycle, which does look the more promising, and the elements of the direct cycle have been changed from metallic to ceramic, which is a new field.

The effort now is about two-thirds on the direct cycle and one-third on the indirect cycle but that is considerably a step up on the indirect cycle because there was very little effort being put on that before.

There has been a great difference of opinion about this program.

As far as I can ascertain now there does not seem to be much of a difference of opinion about it and most people that have looked at it agree that the present course and the present program is about the way we should be proceeding.

Now it is important to note that the Joint Chiefs of Staff position last fall on this was there was no specific military requirement. This

is what caused us to put it into research rather than into a military requirement effort.

The Joint Chiefs of Staff did say, however, that it was of great importance to continue this work and they went on to recommend that we should fly an airplane as soon as possible to ascertain the difficulties that came from flying.

I would say from what I have been advised that we should leave funds in the budget for this program.

Mr. MAHON. Well, this is a difficult question. You are not going to spend all the funds provided for fiscal 1960 that have been appropriated. In other words, they do not feel the program needs more than about $53 million, effective program for 1960.

Dr. YORK. Air Force only.

Secretary GATES. Air Force. This is the Air Force part of it. You appropriated $75 million so there is $15 million or so that is proposed to be reprogramed into other R. & D. programs.

We are dealing with a new field, completely unknown, with new components, new material. Apparently the scientific fraternity believes that both approaches are worth pursuing for reactor development purposes.

There is no possibility that I have ever been advised of that we could fly an airplane earlier than 1965 and there is considerable doubt that we might fly one then. It might be later than 1965.

We are really in, in my lay words, we are really in basic research. That is what we are dealing with, really basic research in a whole new atmosphere.

Mr. MAHON. Yes.

Secretary GATES. Dr. York tells me when these people now again make their annual review, which would comfortably take about 3 months from now, they will come up with another reappraisal of the situation and possibly will make the choice between these two approaches but both are basic research and both are on a new direction than they were a year ago when we really reoriented the whole program into research as opposed to this great effort to get an airplane up into the air that was really a worthless airplane from a military point of view. It had very short reactor life, it had no military characteristics. What you buy out of this airplane, if it ever becomes successful, is primarily range and endurance.

Everything else and every other airplane can be done better but all you get out of this is range and endurance. You do not get high performance so I feel that we should have this research continued and we should be willing to face up to the question of whether we spend all the money that is appropriated and we should face up to the question of method of approach between these two possibilities as soon as we possibly can.

It really has only been 1 year since this new approach was taken and since it is so basic in all these new areas, this is not terribly long and everyone considers this the most valuable way to proceed and the sensible way to proceed.

We are now testifying to you almost in, you might say, the middle of the stream.

There is considerable doubt that there will be a useful military aircraft come out of this, at least there is in my mind, but what could

come out of a compact, efficient, new kind of atomic reactor and what military use that might have has all kinds of possibilities.

REVIEW OF PROGRAM

I haven't been very specific, Mr. Chairman, but that is the background. I think my recommendation would be that we continue to support the program, that you might put some language in the authorization appropriation that would say that we had to have an audit of this and report to you by such and such a date.

Mr. MAHON. What date would you suggest would be fair?

Secretary GATES. Well, let's say September 1 would be plenty of time, would it not?

Dr. YORK. Yes.

Secretary GATES. That would be comfortable.

Mr. MAHON. Would you have your reexamination over by that time?

Secretary GATES. Yes, sir. And you might put a caveat in the appropriation that said we had to report to you. I cannot tell you, Mr. Chairman, whether we need all of this exact amount of money.

REPROGRAMING OF POSSIBLE EXCESS FUNDS

Mr. MAHON. Suppose we appropriated all of the money requested and you changed your views as a result of this reexamination. What would you do with any surplus funds? Should we make them available for no other purpose or how would you suggest we do it in your best interests as Secretary of Defense?

Secretary GATES. We have plenty of high priority research projects that we could reprogram the difference into which would be useful.

Mr. MAHON. You mean it would involve atomic energy matters or just R. & D.?

Secretary GATES. It would not involve atomic energy.

Mr. MAHON. Do you mean to say that you would use the funds for other purposes, then, if you did not use it on the plane? Would you have need for such funds?

Dr. YORK. As the Secretary said, there are plenty of other good ideas around that either can be supported—there are things going on that can be supported more strongly and there are things which at the present time are not supported at all that could well be supported.

Mr. MAHON. Shouldn't we say if funds are not used for this purpose they shall be withheld?

Secretary GATES. Yes. That would be all right.

Mr. MAHON. And not expended for other purposes?

Secretary GATES. That is right. I do not really honestly know whether, let's say, a reduction in the amount of $25 million would be disastrous to us or not. I do not think it would be; but I don't know.

EFFECT OF POSSIBLE $25 MILLION REDUCTION

Mr. MAHON. Would a $25 million reduction in the funds requested through the Atomic Energy Commission in your opinion hamper the program in any substantial or significant way?

Secretary GATES. I would rather ask Dr. York.

Dr. YORK. A reduction on the atomic energy side would probably hamper things more than the same reduction on the defense side, but that is a quick judgment.

Mr. MAHON. It is just a question of the committee wanting to know what to do. You have faced up very frankly to this problem, it seems to me. We just do not want to continue to pour money into this thing if there is no hope of return. We have spent, I believe, in the area of a billion dollars and we do not want to go on and on and on.

Secretary GATES. That is correct.

Mr. MAHON. We feel this program should be very carefully monitored and policed and that if it does appear to be futile that somebody ought to take the bit in his teeth and do whatever is necessary to be done.

That is one of the main objectives we have, that we not just go along indefinitely, throwing money, money, and more money into this thing and come out at the end with nothing to show for our tremendous investment in the program.

Secretary GATES. Well, I would say, Mr. Chairman, from what I know, that we are a long ways from a military aircraft and we may not be a long ways from a very significant result from research toward reactor development.

Mr. MAHON. That might be helpful.

Secretary GATES. What military use that could be put to is probably unlimited. You cannot tell.

REDIRECTION OF PROGRAM LAST YEAR

Mr. MAHON. Let me ask you a few questions which I wish you would respond to to some extent: When you reviewed this program, last summer, in what respects did you alter its direction? That is a question that Dr. York could best answer, I assume.

Secretary GATES. It was going toward—or the effort was going toward a lot of work on designing airplanes and facilities and toward early flight and not enough work in our judgment, although this was controversial, was going toward the development of these unknown components and so we reoriented away from early flight into "Let's make an engine first and fly later."

Mr. MAHON. By these changes did you in fact delay the time when we will fly a nuclear powered plane?

Secretary GATES. Yes. We delayed the time that we could fly a nuclear powered plane but the plane we could fly would be relatively unimpressive.

Mr. MAHON. Assuming a race with the Soviet Union, did you actually decide it is not a sufficiently important matter to be first in air with a nuclear powered aircraft to call for a crash, fly-at-any-cost type nuclear powered aircraft?

Secretary GATES. Personally, I tried to stay out of this field of psychological thinking. I cannot stay out of it as a citizen but I tried to look at it from a military point of view. There is this factor, and it has influenced a great many people, but to me if you flew an airplane that was a facade and had practically no life or no military requirement to it, it was not a very good airplane to be first with.

Mr. PILLION. You are kidding yourself rather than the Russians.

Secretary GATES. You are kidding everybody. It seemed to me it was not much value in just flying a nuclear engine around that had no endurance and had no military significance.

Mr. MAHON. I would like to explore with Dr. York the question of what you may probably know 3 or 4 months from now that you do not know now in regard to this problem that will be helpful to you in making important decisions.

Mr. Taber, I will yield to you.

Mr. TABER. I have no questions of the Secretary at this point. I think he has told us frankly what he believes.

Mr. MAHON. Mr. Sheppard?

LEVEL OF FUNDING OF PROGRAM

Mr. SHEPPARD. I would like to ask a question because of the element of what I call undetermined expenditure requests.

In other words, Mr. Secretary, it is my interpretation that you said there was $15 million already in the status of availability that would not be used.

Secretary GATES. In 1960.

Mr. SHEPPARD. That is correct.

Now, these two composite committee requirements total approximately $148 million, plus $15 million, making $163 million in total. With the new requests that are pending, to which Mr. Mahon has addressed himself, and plus the 15, that gives us $163 million. Under the circumstances that prevail here, is it not rather a large amount to just have up here when we are not going to use it? In other words, we are living in a restricted budgetary concept in all of our military functions. You have had cancellation after cancellation and redeterminations in all factors of our military requirements and due to your adjusting yourself to the restrictive budget requirements. Is this not an excessive amount of money to have in status quo, proportionally speaking?

Secretary GATES. Yes. It is a lot of money to have in that position.

Mr. SHEPPARD. Neither one of these agencies is consuming their expenditure today. I do not see how they could possibly use $163 million. It looks to me like an excessive appropriation.

Secretary GATES. It is a lot of money. It rates around the middle of our priorities. It is an important research program. We have other priorities toward more definitive weapons systems that would require more push and more funds. This is in the land of the unknown and it is important from that aspect.

REPROGRAMING OF FISCAL YEAR 1960 FUNDS

Mr. SHEPPARD. Where would the $15 million be?

Secretary GATES. I think, Mr. Sheppard, we should not add the $15 million. My understanding is it is about $150 million divided between Defense and AEC.

Mr. MAHON. That is right.

Secretary GATES. Of the Defense fund of 1960, there is approximately $15 million that will not be used in 1960.

Mr. SHEPPARD. But in either event the expenditure requested here, even though it is divided between Defense and Atomic Energy, is directed for the same basic purposes.

Secretary GATES. That is correct.

Mr. SHEPPARD. If you come up here and make a request to develop this particular type of powerplant, and we are going to have a diversion here, I think the committee is entitled to know where the diversion goes because the justification on all your R. & D. work has been pretty elaborately expressed as to how it will be expended.

Secretary GATES. I am sure the committee should be advised on how we reprogram this $15 million.

Mr. SHEPPARD. I grant you that, but prior knowledge of it would be very helpful in handling the budget.

Secretary GATES. I do not know where that is going.

Dr. YORK. I do not know where that $15 million is going either. However, the committee may already have been informed about it. The committee is informed about reprograming.

Mr. MAHON. The main point here, gentlemen, is with respect to the public works bill. The Senate could reduce the Defense Department appropriation if it desired to do so in the light of this information, but we of course cannot do that. The bill has already passed the House. If the public works appropriation bill is cut by the $15 million because you are not using the fiscal year 1960 funds and you could reprogram them over into 1961, could you transfer the Defense Department money over to the atomic energy program? I do not believe that you could.

Dr. YORK. It is not normally done. I think of it as being bad practice myself.

SPECIFIC MILITARY APPLICATION

Mr. SHEPPARD. I have no further questions. Very frankly, your statement leaves me rather cool toward the situation, Mr. Secretary. First, primarily, you state as far as you know at the moment, and so far as the advice you have available to evaluate it, this has no literal military use.

Secretary GATES. No specific use.

Mr. SHEPPARD. Under those circumstances the expenditure apparently at this time is a hypothetical one militarily speaking.

It may have ramifications in other fields. It might be in private use for a transport plane or some other situation. I do not know. You must have something in your mind, either you or Dr. York, as to the ultimate use of it. This is what annoys me at the moment, there is such a dire need for actual military hardware.

Secretary GATES. Yes.

Mr. SHEPPARD. That is under the existing budget. It has been cut and cut and cut. Here comes something that is an undefinable situation at the moment. The actual development of the engine can be done on the ground and until it becomes a factor applicable to atmosphere; could it not?

Secretary GATES. We are doing it that way.

Mr. SHEPPARD. Consequently, here is the potential and the question is, when we get it, what will we do with it?

Secretary GATES. This is the question. We are dealing in a new frontier and while we do need military hardware, and we should concentrate on military requirements, we also should have some imagination and go for something that we do not know specifically what it is going to do to some extent in our research program. This is prudent also. We believe that for the moment we should not cancel this program.

Mr. SHEPPARD. I am not advocating cancellation, but it does occur to me, Mr. Secretary, that under the very specific requirements that we all realize, operational requirements, this is something we could take a little more time with and still come out as an end result insofar as the money aspect is concerned. I am looking at the dollar aspect in our requirements as you people have expressed the requirements. It seems to me this is a tremendous amount of money to be held in what I called suspension. I am not addressing myself to cancellation as such.

Secretary GATES. I think you can correctly make that point. Of course, again, speaking as a uninformed layman, the problems of flying a nuclear-powered airplane when we get it up in the air have yet to be analyzed. I mean we have got protection of the crew, safety of the handling of the aircraft, facilities that it flies from and to and this whole field is very much of a new frontier. We have now got it back on the basis that we are going to try and make a proper engine and we are not going to fly until we get one.

Mr. SHEPPARD. That is all, Mr. Chairman.

Mr. MAHON. Mr. Rabaut?

SCIENTIFIC PERSONNEL ON ANP PROJECT

Mr. RABAUT. Thank you, Mr. Chairman.

This research on the reactor development should be by the AEC, should it not, rather than by the Defense Department?

Secretary GATES. Well, we are sharing this.

Mr. RABAUT. Are we not doing this in two places, in a way?

Secretary GATES. We are working as one and sharing the cost and sharing the talent.

Mr. RABAUT. Then this occurs to me. When we think of it as not being too necessary for defense at the present time, it seems that we are spending a lot of manpower at this when maybe we could use it in other places. There must be some very scientific people working on this. Somebody said there are 7,015 people working on this project.

Secretary GATES. I do not know about that figure.

Mr. RABAUT. That is the testimony before our committee.

Dr. YORK. They are by no means all scientists.

Mr. RABAUT. I do not see why this whole project should not be with AEC, the work on the reactor.

Secretary GATES. In the case of developing military reactors, we have for years worked jointly with the AEC.

Mr. RABAUT. We have so much money in it, too.

Secretary GATES. This is a good method of working jointly and sharing talent and trying to devise military requirements. I said to the chairman, we have put goals on this airplane now for both type

of approaches. We are trying to attain an engine which will fly at those altitudes and speeds.

Mr. MAHON. Mr. Jensen?

DOUBT OF VALUE OF PROGRAM

Mr. JENSEN. Of course, this whole thing is quite difficult for any layman to understand. I cannot get myself into the position of thinking that this plane is of any great value or ever will be, either militarily or for other purposes. It is a big, lumbering thing. It will fly only about 35,000 feet high and somewhere between 400 and 600 miles an hour. As has been mentioned before, it will be a sitting duck in any controversy with an enemy.

It is the most difficult thing in the world for me to see where we are justified in appropriating any more money for this because of the reasons I have just stated.

I know, of course, that we do not spare the horses nor spare the dollars when war effort is being made, but the time has come when we just cannot throw these billions and millions away because, after all, a solvent government is the best defense. I hope the time never comes when you might come up here, Mr. Secretary, and find out that we just cannot appropriate very much money for our defense program, and that time could come if we keep on spending like we have been.

There are so many other things now to spend money for, for the defense program, that are much more urgent than this type plane. No one knows yet today, and I do not know that they ever will know, whether this thing will be a success or not.

I have thought that because of the fact we have nuclear-powered submarines, that this plane might be worth the money, but I am beginning to doubt that it ever will be worth the money. I am not a military expert in the slightest sense, but from a business standpoint and a practical standpoint, I just cannot see this thing.

I wish I could feel justified in helping to appropriate these millions and billions for such an experiment.

Let me ask you this question: Is there a number of your people assigned to this research program, or just how is it operated? How do you administer this research, the whole program?

We have a full breakdown on it here.

Mr. MAHON. We can get it from Dr. York.

Secretary GATES. I would like to say we do an enormous amount of soul searching ourselves to pick the things we should put our chips on and have to establish difficult priorities in all areas, weapons systems and research, at the Pentagon, so we are continuously aware of the fact that we should not put the money against something that is not important. If you were going to buy this airplane today, I would agree with you. But what we are buying in this financing is reactor development which may lead to all kinds of new frontiers. If you are buying a slow, lumbering airplane per se, I would agree with you. But we have changed that program to try and develop these components and these engines.

I told the chairman, the only thing we get out of this in terms of an airplane is range and endurance. We do not get performance, we do not get invulnerability, we do not get a bomber. We get range and endurance.

Mr. JENSEN. What good is range and endurance? Now, in this day and age of these fast planes and fast missiles and your radar system we are perfecting to a greater degree every day, I cannot even see where your long range and endurance is of great value or ever will be.

Secretary GATES. There have been cases made that would be supported by some people that continuous antisubmarine warfare surveillance, continuous, would be important. There have been cases made that continuous early warning or reconnaissance type of warning, continuously——

Mr. JENSEN. We have facilities now to get that.

Mr. MAHON. Do you have some questions, Mr. Pillion?

NEED FOR AIRFRAME DEVELOPMENT AT PRESENT TIME

Mr. PILLION. Just one or two.

As I understand the problem, you are at the initial stage of trying to develop a reactor, and then from that point you develop a plane, and then develop a weapons system. You are at that very first stage of even deciding between two methods of developing a reactor for your powerplant.

If the reactor is the important fact you are trying to develop, then why do we spend funds in this appropriation for airframes? Why should that not come in the next program after you have decided pretty much upon the shape and the type of reactor and powerplant?

Secretary GATES. I do not have the complete facts on this, but I understood we were spending funds in the past, but we are not now; we are spending some design money. Is that not right?

Dr. YORK. Yes.

Mr. PILLION. Design of a plane?

Dr. YORK. Yes.

Secretary GATES. Yes, but not to fabricate any.

Dr. YORK. There is very little money in that for that purpose at the present time.

Mr. PILLION. How do you design a plane unless you have a powerplant? It seems to me a waste of money unless it is a very preprelimiinary thing. It seems to me a waste of money to design a plane until you know the size, shape, and speed, and so forth.

Secretary GATES. I think I am correct in saying that we are doing paperwork. We are doing blueprint designing, not cutting metal.

Mr. PILLION. You are doing imagination. You are imagining these things.

Secretary GATES. Yes.

Mr. PILLION. You talked about a report for September 1. Do you think that will give you time for plenty of development? I think there should be a progress report. You should have plenty of time.

Secretary GATES. October is just that much more comfortable.

POSSIBLE SOVIET DEVELOPMENT EFFORTS

Mr. PILLION. There has been talk about the Russians getting a nuclear plane ahead of us. The law of physics and the law of economics and the law of wastages of manpower, and so forth, and effective use of technicians, applies equally to the Russians as it does to

us. If we are engaging in a wasteful situation here, they would be, too, would they not? The same laws apply. If they are wasting 7,000, 8,000, 10,000 people on this thing and they come up with a lumbering boxcar, it is a wastage for them. So I do not think, as you say about the psychological warfare, I would get too excited.

Secretary GATES. I have not gotten excited about it.

Mr. PILLION. Certainly if we are going to engage in a propaganda battle, then we ought to engage propaganda experts and use those laws and tools, rather than the Defense Department and waste technicians in order to try and put across a doubtful propaganda bit of information across the world.

Secretary GATES. I agree completely, sir. I do not think it is our business.

REPROGRAMING OF EXCESS FUNDS

Mr. PILLION. I think we agree on this thing.

By the way, Mr. Secretary, if this money were all appropriated and you had some excess money that you wanted to reprogram, why should it necessarily be reprogramed into research, for instance, if you need—and I am sure you do—mapping. This plane incident brings it up. It is certainly not firepower we need with the missiles as much as target power. We have to get to the targets. Could you apply that money to something like that which is of immediate, pressing need, rather than into another research thing which may not have immediate usefulness to your target power?

Secretary GATES. No, sir.

Mr. PILLION. Off the record.

(Off the record.)

Mr. MAHON. On the record.

In view of the fact that the Secretary of Defense has an important engagement at the White House at 11 o'clock, it is necessary for us to make this first meeting with the Secretary of Defense rather brief. If this special subcommittee continues to function and we make a thorough study of the problem of nuclear-powered aircraft, we will, of course, have to go very thoroughly into many matters, and we will have to have extensive hearings and probably a staff study as well as our own hearings, in addition to our own inspection trips which we may make to inform ourselves as to what may possibly be done or what may best be done.

It is not my thought that we would go into an extensive hearing with Dr. York at this time. That can also come later. But I thought there might be some questions we might clarify with Dr. York.

Mr. TABER. There is one thing I have.

Mr. MAHON. Mr. Taber.

Mr. TABER. That is this: There was an appropriation to the Air Force for this current fiscal year. That is right, is it not?

Dr. YORK. Yes, sir.

Mr. TABER. Of that, there will be about 15 million left. Was there an appropriation to the Atomic Energy Commission, also?

Dr. YORK. Yes, of about $70 million or $75 million.

Mr. TABER. Are these funds exchangeable between the AEC and the Air Force?

Dr. YORK. No, sir.

Mr. MAHON. The indications are, from our record here which has been made available by the Department, that for the fiscal year 1960, the Air Force will expend $59.2 million and the Atomic Energy Commission will spend $63.9 million. Those are the facts which have been given. As you know, from year to year they estimate how much they may need on these programs. It is pretty difficult to estimate in advance what you will need on a research and development program of this type. We are glad you are not going to spend all the money we have provided, unless you can spend it profitably.

Mr. TABER. You do not need, as I understand it, if you get $75 million out of the new bill, the $15 million carryover?

Dr. YORK. I believe that is correct, Mr. Taber, that the $15 million has probably already been reprogramed, but I would have to check that and be sure.

Mr. MAHON. It probably has.

Mr. SHEPPARD. Just a minute, Mr. Chairman. Am I to understand from that that reprograming is not directed and cleared by the chairman of this committee?

Mr. MAHON. It is.

Mr. SHEPPARD. Then we know definitely what has been done with it.

Mr. MAHON. We do not have the facts at our fingertips. We will have to check on it.

Dr. YORK. There have been a number of reprograming actions, and which one has involved which money, I just could not say.

Mr. MAHON. Here is the testimony of General Wilson, on page 469 of the Defense hearings:

> General WILSON. This program has changed somewhat in character, and the emphasis has shifted from an almost total preoccupation with the direct cycle to emphasis on the indirect cycle. The end requirement for fiscal year 1959 is $59.3 million. The remaining $15.7 million has been reprogramed to other projects and has been reported to Congress.

That was at our hearings. Prior to that, on January 29, 1960, the committee was officially notified by the Department of the reprograming action.

Mr. JENSEN. It has been reported.

Mr. SHEPPARD. That, to me, does not mean too much.

Mr. JENSEN. Let us understand this thing. When the Interior Department or the Army Engineers want to make transfers, that is what you call reprograming, I presume, from one concept to another, or one part of your agency to another. The Army Engineers and the Bureau of Reclamation call the clerk of our committee and the clerk then contacts our subcommittee if we are in session, or he contacts the chairman of the committee and the ranking Republican on the committee and explains the request for the transfer, and if we think it is justified we say "OK; go ahead." If not, we say "No."

Now, my question is, as I understand this situation that exists today the Secretary of Defense has simply programed this $15,700,000 and just reported it to Congress and has not got the consent of the committee to make the transfer, is that right?

Dr. YORK. It was reprogramed within the same appropriation, namely, R. D. T. & E., Air Force, and I am sure you know more about the rules than I do, but we are required to report reprograming of more than some amount, which I believe is $1 million.

Mr. MAHON. The matter of reprograming is usually considered as a subcommittee matter. Subcommittees function differently in the way they handle reprograming.

Mr. JENSEN. Did you give your approval to transfer funds or isn't that necessary under the rules here?

Mr. MAHON. My point is that there are thousands of budgeted projects in the Defense Department. Officials submit their estimate of what each one will require, but they are rarely exactly right on the nose with respect to projects and they go over on some and they go below on others. That is our problem. We require that we be kept informed of developments, and the committee gives clearance to certain significant reprograming actions.

Dr. York, in your capacity, do you approve or disapprove every reprograming action?

Dr. YORK. The situation is this, Mr. Chairman: That any reprograming of more than $2 million requires prior approval from my Office and there are a great many restrictions on that kind of reprograming over and above that. For example, the reprograming can only be done within an appropriation and not from one appropriation to another, or from one service to another. We require prompt notification of reprograming of less than this figure. The $2 million figure was selected on a practical basis of reducing to a workable amount, a workable number, the number of cases that did require reprograming and therefore required weeks of delay that it takes always to study these things. In other words, we prefer to set reprograming at a figure which will result in a sufficiently low number of cases so that we actually can, as a practical matter, look into these cases as opposed to simply being perfunctory about it.

Mr. MAHON. Thank you very much, Dr. York. We appreciate your coming down. We will write a letter to the Secretary of Defense asking formally that this program be reexamined, et cetera. Of course, you are in the process of doing that, as I understand. We will expect you to report to us approximately on the 1st of October as to what changes are deemed to be advisable as of that time.

Dr. YORK. Yes, sir.

Mr. MAHON. Thank you.

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